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'DIP.TECH.(ENG.)'

THE FIRST REPORT OF THE NATIONAL Council for Technological Awards, under the chairmanship of Lord Hives, has recently been issued; it covers the period from December 1955 to July 1957. The work of this new Council and the diploma it awards are of particular interest to electrical engineers, since the Council of The Institution hope that all those who receive a diploma after following a course in electrical engineering will also obtain complete exemption from the educational requirements of The Institution. The award for engineers will be known as 'The Diploma in Technology (Engineering)', or 'Dip.Tech.(Eng.)'.

The maintenance of appropriate standards for the Council's awards is now the function of two separate Boards of Studies, one of which is concerned with engineering studies. The Institution is strongly represented on that Board, and on the Subject Panel which is concerned with electrical engineering. Members will, doubtless, recall a number of references made in the *Journal* a few years ago to the discussions between representatives of the three major engineering Institutions and the National Advisory Council on Education for Industry and Commerce, as a result of which certain of the three Institutions' suggestions were adopted.

At that time some members were doubtful about the possibility of maintaining an adequate standard in the new diploma, and, also, whether there would be a substantial demand for it. One of the critical features which will determine the success, or otherwise, of the new award is the limitation of approval of courses to those colleges where adequate facilities and highly qualified staff are available.

It is evident from the first report of the Hives Council that much time is being spent and much trouble taken by the members of the Boards of Studies, and Subject Panels, to examine in detail college facilities, staff, and particulars of each course itself. During the period under review eight courses in electrical engineering were recognized at seven colleges, and five courses were rejected. It is particularly interesting to note that, of the eight courses accepted, seven are of the six-month sandwich type. It is to be hoped that industry will be prepared to release more men for this type of course, so that the numbers of students attempting to satisfy the membership requirements of The Institution through the medium of part-time day release and National Certificates may be drastically reduced.

It is encouraging to learn from the report that high standards of entry qualifications are being maintained, for the importance of this point was stressed by The Institution's representatives during the early discussions.

In commenting on buildings, the report draws attention to many deficiencies, even at those colleges which have been accepted, and expresses the hope that these will be rectified during the next few years. Some leniency in these particular requirements is obviously necessary initially, and the Hives Council's approach to this problem seems to be realistic.

In a foreword to the report, Lord Hives states that the number of students studying for the new award is 965, but the report does not indicate how many of these are studying electrical engineering. But it is fairly evident that the impact of the new award on electrical engineering education has so far been relatively small; it is very much to be hoped that in due course larger numbers will enter these courses.

The Hives Council are already setting up a special committee to make recommendations concerning post-graduate awards; but it seems premature to give serious consideration to such a development before the first diploma at graduate level has been awarded. The need for such awards is not yet clear; presumably they would connote some additional specialist study within the scope of the technology concerned, and by attracting men with university degrees would assist in supporting the high standard and good name of the Dip.Tech.(Eng.).

One of the appendices to the report gives details of the proposed examination arrangements. These would seem to suggest that extreme caution is being exercised in the provision of communication between the Council and the external examiners. It is very difficult to envisage how adequate standards are to be maintained, particularly in the first formative years, if the external examiners have no very clear idea of the Council's requirements. This is a point that would warrant further consideration.

On the whole, the Hives Council are to be congratulated on the excellent way in which they have begun, and all members of The Institution will wish them well in their further endeavours.

THE FOURTH GRAHAM CLARK LECTURE

Sir Ewart Smith, M.A., F.R.S.

discusses

The Engineer and Management

This Lecture was delivered at The Institution of Civil Engineers on the 17th December 1957

I AM very conscious of the honour and responsibility involved in presenting the Graham Clark Lecture, particularly as I am the first engineer to do so. These feelings are enhanced because I had the privilege of knowing Graham Clark personally, and because I greatly admired his humanism and breadth of vision. I share his belief that it is no less important to study people, and to organize them effectively for co-operative endeavour, than it is to study the material factors which affect the life of mankind, and in which engineering science plays such a vital part. It is on the subject of the interrelation of the technical and human problems of modern life that I wish to talk to-day.

Like my precursors, I have elected to deal with a very wide theme, but, I fear, without their clarity of mind or of expression. Before talking about engineers in particular, I should like to say something about the problems we face, about management in general, and about the form of education and training conducive to a high level of managerial ability. If I over-simplify or lose my way in attempting to follow by-ways of thought, I can only ask for your indulgence. My hope is that I may in some respects, at least, provoke controversy, for any constructive conflict of ideas may help us on the road of progress.

The Crucial Problem of Society

Man in his struggle to live has always sought to control the physical conditions of his environment. At the same time he has had to contend with problems arising from his social and organizational relationships, and as a result of his innate urge for self-expression and love of power.

The advance of science and its practical application through engineering and chemical technology has now shown that mankind has the potential ability to achieve any standard of material well-being that may be desired. But any effective movement towards such a state must be subject to one overriding condition: that some effective limit must be set to the growth of population, having regard to the availability of natural resources and of space on this small planet. This is underlined by the fact that since 1900 it is estimated that world population has risen from some 1 600 million to no less than 2 700 million.

When we turn to the problems of human organization, we find that no solution of the difficulties and complexities is yet in sight; rather, they are tending to increase, owing in large measure to the very factors which are improving our material state. All mankind is becoming aware of the differences of wealth between race and race, and between class and class, and all now seek a quick improvement in their own conditions of life. This attitude has been fostered by the rapid technical advance in methods of communication—physically by the automobile and aeroplane; orally by the radio; and visually through the cinema and television. In addition to this ferment of ideas, we now have to cope with all the implications of nuclear energy for purposes of peace or annihilating war. All these developments have occurred in their entirety during my lifetime—to me, at least, a very short period. It appears that materialistic ideas have spread, while ethics seem to have declined in inverse ratio; increasing emphasis is put on rights and less on duties. In a world where power is still the final arbiter, dictatorship, mass strikes, or the inter-continental atomic missile, pose dangers and difficulties of control far beyond those of former ages.

However much we or our successors may sigh for the relative simplicities of bygone years, it is idle to think that the march of science can be restrained in a highly

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competitive and questing world. All the indications are that the rate of technical progress will further accelerate as time goes on. The front available for development grows automatically as the boundaries of research extend in every direction and the additional area of knowledge, thus uncovered, must increase as the square of the linear advance. It is a frightening thought, but it must be faced, that this will make industrial, economic and political management ever more complex and difficult as the years go by.

All this can be summed up by saying that technical progress during the last two centuries, and particularly during the past fifty years, has been much faster than the rate of advance in our ability to manage our affairs effectively, either in industry or in society at large. It is easy to blame our industrial and political managers, whether past or present, for this state of affairs, but we cannot shrug off our own responsibility in this way. Our industrial civilization has mainly arisen as a result of the invention and work of engineers: have not we, then, as engineers and scientists, a special responsibility to play a more active part in attempting to solve the problems of management and organization that now confront mankind? The need is to bring the material and psychological realities of life into better harmony, and to secure greater mutual understanding and closer unity of purpose. We have to organize the extension of collective action, but with full regard to the need for individual freedom. As I see it, this is the crucial problem of society. It exists to a greater or lesser extent in every organization, from the small unit of business up the scale to large industries, to the nation, and indeed to the world as a whole. It is the problem of management in the widest sense.

Some Principles and Functions of Management

If the broad conclusion is accepted that the furious rate of advance in science and technology is not being matched by equal progress in our ability to control and to manage, it is proper to seek reasons for this lack of balance.

The physical sciences are based on the factual and unchanging laws of nature. They lend themselves to measurement and to the logical methods of scientific analysis, unaffected by human emotions. The proven results of research in this sphere can be precisely recorded and thus provide a firm base for further indefinite advance by succeeding generations.

The sociological and managerial problems of mankind cannot be approached in the same way. They are bedevilled by emotion and the historical prejudice of race and class, nor are they subject to precise 'natural laws' which can be exactly determined. But this does not rule out the possible existence of fundamental principles on which logical and effective rules of conduct and procedure might be developed. Indeed, I am convinced that such principles are there for the finding, but the fact that we can only grope for them in an empiric manner enhances the need for objective examination and analysis.

As a design engineer, I formed the belief that three such principles were those of simplicity, symmetry (or balance), and continuity; I at least have found it helpful to consider their import in all problems of basic design. As a manager, I have subsequently been forced to the conclusion that these ideas are also applicable to organizational structure, and to the general concepts of management. We must remember, however, that in human affairs, as in nature itself, there is no static state, though there should still be continuity—that combination of continuity with change which we call evolution. It is on the positive *rate of change* which we achieve that we should judge ourselves, and be judged by others—for efficiency and progress can be measured only in relative terms. But again this should not imply that absolutes do not exist. In the material world we have examples in the velocity of light and in the absolute zero of temperature, which has now in effect been reached. In non-material things, it can scarcely be an accident that throughout the ages the leaders of thought in religion and philosophy have had similar ideas. Because man is part of the cosmos, it is surely reasonable to expect that truth—could we but discern it—will not have different rules, or a different face, for the material and the non-material sides of life.

Let me quote a few examples which support the view that the three principles I have mentioned have a basis of reality and when followed lead to good results. In the past such solutions have often been reached by trial and error, but progress would be quicker and more certain if we consciously sought to use them when analysing our problems.

In engineering, an obvious case is the basic simplicity, symmetry and continuity of rotary motion in comparison with reciprocating action. Similarly, the advantages of symmetry are brought out by a technical comparison of the high speed, vertical, A-frame reciprocating prime mover or compressor relative to the horizontal type of machine. In general, the advantages of the continuous process, relative to batch working, apply in every industry, and not least in chemical and petroleum production. It is well known that discontinuities in form have bad effects in raising stress, but this is all too often overlooked because the background principles are neglected or untaught. As an example of the aesthetic violation of symmetry and continuity, I would point to the skyline of some of the new buildings in London, which certainly affront the normal eye. Conversely, many modern designs of buildings, of monolithic concrete dams, of aircraft, and of many types of equipment, illustrate the beauty, utility and efficiency which can result when these principles are applied with imagination and integrity.

In management, it is a matter of experience that a good organizational structure is usually one which is simple in form, balanced in its proportions, and clear in its lines of responsibility. Where, for instance, a senior has only one, or conversely very many, immediate subordinates, the result is likely to be bad. Then again,

in large organizations difficulties will arise unless functional services are symmetrically related to the operating sections which they serve in common. The importance of continuity in the succession of good senior executives is now generally recognized, but how many organizations have suffered, or even died, because this principle was neglected till it was too late.

In the political field, an able dictator may for a time produce good results, but because under such a system there can be no continuity, and because there are no proper 'checks and balances', sooner rather than later, evil will result. That is not to infer that political and industrial democracy, as we know it to-day, is the ideal or only alternative. This system may be the best which mankind has yet evolved, but it has still to prove itself able to solve many of the problems of industry or of national and international government. In this connection, the principles which I have been discussing do *not* include uniformity. That seems to me to be a false ideal of those who misunderstand true democracy. It brings no real and lasting satisfaction either to the individual or to the mass of mankind, and in material things it leads to neither beauty nor efficiency. Similarly, in social affairs, egalitarianism and uniformity by their very nature must tend to halt, rather than encourage, progress.

In the past, management has been regarded almost wholly as an art, and it is still often said that 'the good manager is born, not made'. But this is surely one of those half-truths which can be as misleading as a downright lie. There is now strong evidence that there are detailed techniques of good management which can be tested, defined and, therefore, taught. Management has many similarities to medicine and needs to be treated as a science, just as medicine has been scientifically developed for a century or more. Nevertheless, each must always, in part, remain an art, the standard of which will depend on the individual quality and experience of the practitioners. The fact that medical science is incomplete does not put a premium on witch-doctors or make us think that physicians should learn their job only by observing the day-to-day practice of their seniors, as once they did. This is still the way in which most managers learn their job!

The need is for more research, better analysis and, above all, for better teaching in connection with management subjects. Although I believe that formal teaching can help to make better managers, I certainly do not mean to imply that good managers—any more than good doctors—can be made in the classroom. Teaching and experience need to go hand in hand.

In comparison with the rate at which knowledge is accumulating, the capacity of the human mind and the span of human life are virtually fixed. Thus, specialization becomes essential, not only between one type of activity and another, but often within the different sectors of the same field. Nevertheless, this should not mean that everyone must be educated and trained as a specialist from the age of 14 or 15 onwards; unfortunately, the whole social and educational system has been moving rapidly in this direction. There is a real danger th specialization and research may be regarded as en rather than as aids in achieving an integrated resu It does not seem to be widely appreciated that the ve growth of complexity and specialization creates a increasing need to train with great care those who w have the responsibility of co-ordinating the work of t specialists. This is important within the fields of scien and technology, but it is even more vital that top manag ment in industry and in the governmental machine shou have the background of knowledge and experience t ensure that the technical and humanistic sides a handled in a balanced and integrated way. Integri should, in fact, be added as a fourth basic principl which, like the others, is applicable to technical an humanistic problems alike. Its twin meanings 'wholeness' and 'fundamental honesty' are both appro priate to my general theme.

The function of the specialist should be to help, not t control. Equally, general (or line) management cannot d its own job effectively unless it has a good understandin of the work of the specialists and uses them properl It is not difficult to think of cases where line manageme has tended to abdicate its proper responsibilities t experts, or specialists, with very detrimental results.

In this connection, it may be pertinent to differentia between the 'expert' and the 'specialist'. In my view, t former is a man wedded to one line of country and wh knows the answers—or thinks he does! The latter is on who is concentrating *for the time being* on a particul subject and is still in the conscious process of learnin he is willing to give reasons, or to admit ignorance, a occasion demands. For many, specialization once starte may continue through life, but this need not involve th rigidity of mind that all too often goes with expertise.

It is a matter of common observation that progress o any problem is most likely to be achieved from attack b the specialist working in conjunction with one who ha a trained and critical mind, but no detailed knowled of the subject. If neither is allowed to dominate the othe there will be mutual stimulation, and extremes of eith a conservative or an impractical nature will be avoide Here is another typical example of the application o the principle of symmetry and balance.

Selection and Training for Management

It is a truism that both mental quality and person characteristics can be improved and developed b appropriate education, training and experience. Neverth less, we sometimes forget that this applies not only duri the years of childhood and adolescence, but up to th time when the will to learn and flexibility of mind a lost. For each individual, this critical age depends part on his personal make-up, but can be great influenced by the way in which he has been educate and developed during the preceding years.

Men are not equal in their innate mental capacity in their personalities, nor do they have the same natur interests. There is no such being as the average ma

Even if the economists and politicians assume the existence of such an abstraction, we, as managers, must remember that we are dealing with persons of infinite variety. If each individual is to be developed to his potential limit, he must be studied carefully at every stage, and then be given the treatment which is likely to be most appropriate.

We must also encourage each man to examine himself, but as a necessity of corporate existence make it clear that judgment must rest with others. It is vital that this judgment should not only be thorough and objective, but that it should be made in such a way that it is acknowledged to be so. To this end, regular, multiple and independent assessments are of the greatest value to man and management alike. Such considerations underline the narrowness and shortcomings of the way in which we normally handle people.

Some people by nature or environment, or both, tend to have their main interest in specialization. At the other end of the scale are those who get bored if they stay too long on one type of work, and prefer to take a wide view of life and have a variety of experience. Such men are more often interested in people than in things; they are of the co-ordinator and manager rather than the specialist type. Between these two extremes are the large numbers with a mixture of interests and abilities in accord with the law of Gaussian distribution. There are some who could become supremely good throughout the range, but few who have both the ability and the opportunity to do so.

In order to sort out, develop and use individuals to the best effect, it is important as a start to give them a variety of experience as quickly as possible. This will enable the man himself, and his leaders, to learn in which direction his chief interest and abilities are likely to lie. Those who then proceed to permanent specialization will have been given a valuable insight into other types of work to which their future activities may well be complementary. For those who are ultimately to undertake wider managerial duties, this background of experience will be of the utmost value. Training has been defined as 'learning by doing'. This applies to managerial functions as to other things, and especially to developing the personal qualities of leadership and decision. It is rightly said that 'responsibility is taken, not given', but how often it is withheld, especially from the young.

In the long term, the health and progress of any organization, be it big or small, depends primarily on the quality of its leaders. It should, therefore, be a main responsibility of top management to pick its own potential successors and to train and test them with the utmost care, from the *early years of service*. The conscious aim should be to place each new generation in the best position to benefit from the accumulated knowledge and experience of its forerunners. As time goes on, this will require the period of formal education to be lengthened, and call for increased attention to the methods and scope of subsequent training and development.

It may be argued that things do in fact work reasonably well under present arrangements; that exceptional men can manage without a broad background of experience, and that to-day it is impossible to train people in every facet of knowledge that may be desirable. Nevertheless, the vast differences to be observed in technical efficiency, and in human relations, between companies, industries and nations, are clear evidence of the scope that exists for further advance. It is also apparent that those organizations which are already in the lead usually continue to make the most rapid progress.

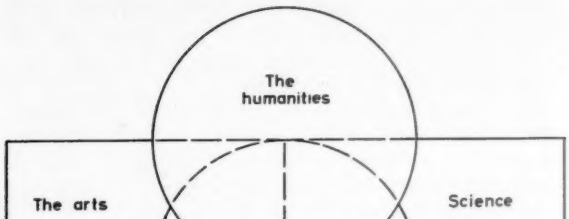
Science, The Humanities and Education

It is encouraging that discussion has recently begun on the general content of educational courses. In particular, the dangers of early and one-sided specialization in the schools, and the dichotomy between the sciences and the humanities—both in school and at the universities—are being called in question. Both these related aspects do indeed need urgent examination, if we are to produce managers able to deal effectively with the problems we now face, and the yet more complex ones of the future.

From the point of view of improving management generally, the split between the humanities and the scientific disciplines is probably the more important and certainly the more difficult to remedy in view of our conservative attitude to education. It would be well if humanist and scientist alike would remember with humility that Leonardo da Vinci was outstanding, not only as an artist but also for his researches in anatomy and for his work as an engineer; that Newton wrote his *Principia* in Latin, and that the Greek philosophers were concerned no less with science than with ethics. It is now becoming plain that there is a desperate need to recreate a similar breadth of approach. It should not be a question of science *or* the humanities, but of how they can be reunited in everyone who claims to be reasonably educated. Blame for present conditions must not be imputed only to educationists, but to the whole community. Industry itself has been slow to appreciate its own dependence on higher education, and I have already pointed out that its methods of training and handling people often leave much to be desired.

Most engineers like, where possible, to visualize ideas in concrete form and to be clear about terminology. With this in mind, I venture to suggest that the broad relationship of the arts, the humanities, science and technology can be shown in diagrammatic form (see page 72). For this purpose the four terms are taken to have the meanings given below the diagram.

This diagram should be regarded as consisting of the arts and sciences as a base on which the humanities and technology are superimposed. It brings out clearly that the arts and sciences meet, but that the humanities and technology overlap each other and, at the same time, both the other disciplines. The use of rectangles and circles is symbolic. Art is entirely subjective and is a matter of opinion, while science is completely objective in its nature; on the other hand, the humanities and



The arts concern the application and appreciation of skill directed to the gratification of taste and the production of what is considered beautiful.

The humanities cover the study of human nature and affairs, and the evolution of moral values.

Science deals with the discovery and correlation of knowledge relative to the unchanging laws of nature.

Technology involves the application of knowledge derived from science to the use and service of man.

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technology each involve *both* the objective and subjective approach. A position on the extreme right or left of the diagram implies complete specialization; conversely, a point on the overlapping central portion represents a combination of two or more of these four broad aspects of human knowledge and endeavour. Leonardo himself would, I submit, be a pre-eminent example of a man standing at the very centre of the diagram, trained and able to operate successfully in any direction. Similarly it is possible to place the musician, the doctor, the architect, the industrial manager, or, in fact, any professional man in his appropriate position.

While I was struggling to express these thoughts, my attention was drawn to the 1957 May Lecture of the Institute of Metals, given by Sir Eric Ashby on 'Humanities for the Technologist', where he puts forward very similar ideas. I should like to quote much of his paper, but one extract must suffice:

> Even members of the House of Lords find themselves called upon to make decisions about radioactive fall-out, about overheating during supersonic flight or the strontium content of bones. Dare I suggest that, in order to be a gentleman nowadays, one has to be something of a technologist?
>
> But technology alone will not make a modern gentleman. It is nothing new to suggest that technologists should know something of the humanities. I want to go farther; I want to suggest that certain of the humanities are an integral part of technology. 'Technological humanism' is not just a rhetorical phrase; it has genuine content.
>
> For technology is inseparable from men and communities. In this respect, technology differs from pure science. It is the essence of the scientific method that the human element must be eliminated. Contrary to the assumptions of some people, science does not dispense with values; but it does eliminate the variability of human response to values. It concerns itself only with phenomena upon which all qualified observers agree. It describes, measures and classifies in such a way that variation due to human judgm is eliminated.
>
> Unlike science, technology concerns the application of science the needs of man and society. Therefore, technology is inseparab from humanism. The technologist is up to his neck in hum problems whether he likes it or not.

If we accept the need for a broader approach education, I am certain that the main change has to tak place in the schools rather than in the universities, b the latter hold the key to this change in their scholarsh and entrance examinations, and in the length of cours up to a first degree.

There is a growing body of opinion that such a scho curriculum should centre round both history and classic physics. Each is essentially a dynamic subject which c be made of absorbing interest to most teen-age pupils it is well taught. By good teaching, I mean that whi seeks to impart a clear general *understanding* of the su ject as a whole, while bringing in detailed knowled primarily for purposes of illustration and for training method. Each of these central disciplines must be su ported—history by language as necessary for communic tion, and physics by mathematics as an essential tool f all scientific work. Such a curriculum would put an e to the curse of early and undue specialization at scho It would also have the advantage that adolescents wou no longer be forced to choose a career at an age when t majority are ill-equipped to do so.

University education must, of course, be based specific disciplines, but up to first-degree level, cours should still be kept reasonably broad. Those who ne advanced learning in a subject should surely acquire during the post-graduate stage, and during their subs quent careers. In any event, it is a mistake to think th three years is still an adequate period for a full universi course in scientific and technological subjects. Of all t great nations, this country is almost unique in its failu to make the changes in this respect which mode conditions demand.

In every field, factual knowledge is now accumulati so fast that we should cease to regard the human mi as the proper or main repository for it. The need is spend far more time during the whole period of educati in teaching how to use knowledge, and where to obt it in codified form, when it is required for work in l life. In academic work it is all too easy to study p ticular trees to the point where there is no vision of wood as a whole, and still less of its relation to the wi landscape in which it is set. We must beware of putti knowledge on the pedestal that should be reserved understanding.

Let me add a word about the movement to incl humanistic studies in the university curricula for scienti and technologists. If this is intended to correct the er of over-specialization at school, it is obviously tackl the problem in the wrong way. If it is part of an integra plan to turn out balanced individuals of flexible t who have wide understanding, rather than specialis knowledge, there is much in its favour as providing tributary of the whole stream of education. This is

idea on which Keele has been founded and is a welcome reversion to much that was good in the old Scottish attitude to education. Above all, let us remember that good education depends primarily on good teachers and relatively little on buildings and equipment.

In all this I am speaking principally of those who have the innate ability to benefit from an advanced secondary education, in effect those who thereafter go, or should go, to college or university. These are the people who will mostly enter the professions and be the managers of the future, and who are discussed by Mr. Peterson in his recent admirable book on 'Educating our Rulers', and by Jose y Ortega in his 'Mission of the Universities'.

It is agreed on all sides that education should aim at equality of opportunity, but selection must have regard to character as well as to brains. Democracy will not flourish if education caters only, or even primarily, for what has been called the 'mass of mediocrity'. Progress towards true freedom, including the elimination of both want and fear, requires that special attention be paid to the *élite* who will be the top managers and leaders of to-morrow. But they must be educated for the conditions they will have to face. It is a grave disservice to the community that half of these people should have little or no knowledge of the principles of science on which our civilization now rests, and that the other half should have scarcely any conception of the cultural origins and historical development of that civilization.

The Engineer as Manager

Sir Harold Hartley, in the first of these Lectures, suggested, in a slight modification of Thomas Tredgold's words, that 'engineering is the art of directing the resources of nature to the use and convenience of man'. This demands that we, as engineers, understand and apply the laws of nature, but if rapid progress is to be made, it also requires the highest standard of management.

Most people are clear as to what is meant by physical science, but the term 'management' is one of those vague words, like democracy, which can mean very different things to different people. I have already used it many times, and it may therefore be helpful to make plain the meaning it is intended to bear in this paper, by giving my own definition. This is general in form, but draws attention to four important aspects which are inherent in any managerial function. It is equally applicable to the office of Prime Minister, the head of an industrial organization, a trade union leader, or a foreman.

First, the manager must be ready to organize and plan in a dynamic manner, after analysing all the facts of the situation with which he is faced. Next, he must make the appropriate decisions and exercise executive control over the operations for which he is responsible.

Then, because every manager is concerned with people he must have regard always to the human and psychological factors, which are of such major importance. To a greater or lesser degree the human aspect of management must involve leadership, that vital quality which Field-Marshal Slim has described as the ability to get people to do what you want, first by personal example, secondly by explanation and persuasion, and only in the last resort by pressure or the compulsion of sanctions.

Lastly, but by no means of least importance, is the need for the manager to have a clear idea of purpose, and to state the objectives in terms which his subordinates can fully understand. As external conditions change, he must always be ready to re-examine his own aims and methods. Because progress in the techniques of science and of management is unceasing, the manager has the opportunity to effect continuous improvement. Such a dynamic attitude is a necessity for good management, but it needs to be inculcated in the young to a far greater extent than is now the case.

My definition attempts to embody these thoughts by saying that management involves 'the organization and control of human activity directed to specific ends'.

If we turn now from management in general to engineers as managers, it would appear that the basic training and subsequent experience which are normal for the professional engineer should be pre-eminently suited to the development of good managerial qualities. Every engineering activity has a clear and immediate purpose, the achievement of which demands planning, decision and control. The engineer is brought up on the idea of change and progress. He has to carry responsibility for his work and results more directly than in almost any other profession; his mistakes are there for all to see, and he has either to correct them or live with them—a most salutary fact. Engineering, too, always depends on co-operative action with other people. The engineer is exceptional also in having the opportunity to see management from the under side, and to gain experience of rank-and-file reactions during his period of practical training. Thus the professional engineer should be well-equipped to undertake wide managerial responsibilities. It is beyond question that he normally does so with success in his own field.

Nevertheless, in spite of these inherent advantages, we must admit, if we are honest with ourselves, that in this country at least, engineers, relative to the contribution which they should be able to make, are not numerically outstanding in the field of senior management in either industry or government. Attention was drawn to this position by Mr. Bosworth Monck in his paper on 'The Status of the Engineer in Management', read before the British Association in 1954. He showed that even in the engineering industry proper, 40% of companies had boards with no technically qualified member, and that of all directors of engineering companies, less than 22% had technical qualifications, and of these only three-quarters were engineers. In the field of general industry, including services such as transport, and in spite of our growing dependence on mechanization and engineering in some form or other, the position is, of course, far worse. If we look still wider—at Parliament as the national level of management—we find that it is rare to have even one qualified engineer in a ministerial post.

If all were well with the national economy, the ordinary

citizen would be justified in believing that present management was satisfactory, from whatever disciplines it may be drawn. But who, taking an objective view, can feel that as a nation we are to-day as strong as we might be in a material sense, or that we are happy in our spirit? The engineer, by virtue of his professional knowledge and his potential aptitude for management, should have a major contribution to make in solving both the technical and the psychological problems which we now face.

What, then, are the reasons which now tend to prevent engineers taking a greater part in general management, as they do in some other industrial countries? Why is there this anomaly in a country which led the Industrial Revolution and which, more than any other nation in the world to-day, is dependent for its very existence on technology and on a scientific attitude in management?

In my view, the main reason lies in our present acute shortage of engineers and other technologists, which tends to confine them to their own specialist work. If more of them had been available, and if a greater proportion had been encouraged to undertake general duties, they would play a wider role in top management in both industry and government. Because of their background there would then have been a quicker appreciation of the march of events, including the need for producing more people of the same kind! Then again, because of conservative traditions, e.g. in the Civil Service, the freedom of the technical man to gravitate to the administrative and managerial side has often been restricted. Owing to the vicious spiral which we have created, engineering has tended to become more and more a matter of technical specialization. In consequence, full use has not been made of its potential value as a training for the broad field of general administration. The methods of scientific analysis are applicable to management as they are to technical problems, and can yield results which are no less far-reaching: science and the humanities are not enemies, but each the necessary complement of the other.

Relative to many other disciplines, engineering also suffers because, by its very nature, it is concerned with the application of general principles—either scientific or empiric—to detailed problems. This involves a converging mental approach, which can be cramping unless it is countered in appropriate ways.

Once this danger is clearly recognized, it may be minimized and, in effect, eliminated for all who are not of the purely specialist type. What is required first is a broadening of education; secondly, that all young engineers should be warned of the risk; and finally, that they should be given wide experience and responsibility during their formative years, on the lines already discussed. We have to recognize that, since the time of the Stephensons, Brunel, Kelvin and Parsons, the corpus of engineering knowledge has become so vast that subdivision is essential. But this makes a broad grounding more, not less, important and calls for increased attention to be paid to the important collateral issues which are involved. These include the economic impact of engineering on society and the general problems of training and management to which I have referred.

Even a cursory study of the biographies of the great engineers of the nineteenth century brings out forcibly certain common features which have a vital lesson for us to learn—or rather to re-learn—to-day. They knew that great results can be achieved only by effort and persistence; they did not hesitate to take considered risks. They combined the analytical and experimental attitude of the scientist with the enthusiasm of the engineer to apply knowledge to useful ends. As members of our Institutions know, their interests and activities in each case covered not one, but many fields of activity; thus, Faraday was a notable chemist, as well as the father of electricity; Brunel not only built railways, but also was pre-eminent for his vision in designing and building bridges and ships; Parsons made great contributions to optics in addition to his development of the steam turbine from a bare idea to large-scale application. But perhaps most important of all, they took, and were encouraged to take, major responsibility while they were still young. In consequence, they were dynamic in their handling of technical problems, and most of them also became outstanding as managers and leaders of men.

To-day, conditions are far more difficult and complex than those our forebears had to face, but the possibilities of advance have correspondingly increased. There is no reason to suppose that the incidence of *natural ability, initiative and enthusiasm* is less than in former generations, but opportunities for displaying these qualities are fewer, owing to the greater rigidities of our present society, and because in many branches of engineering the pioneering stage was followed by one of relative complacency, from which we have only been shaken by two world wars and the example of other nations. The work of our British engineers and scientists in the field of nuclear power during the past ten years has shown what can be achieved when energy and courage are given proper scope.

The engineer should be concerned with much more than technical design and production to meet stated needs. He should be in a position to apply his powers of analysis to the reasons which prompt the requirement and to proposing the best solutions which science and imagination can provide. He should be ready to go further still by considering what the social and economic impact of his work is likely to be. His role in top management should not be 'as technical adviser' to those who have no scientific or technical training; he should be able to take a full part in leadership and in developing the forms of organization and methods of management which will be most effective in a changing world.

Conclusion

Industrial civilization as we know it to-day has largely been built on foundations of science and technology which Britain created in the eighteenth and nineteenth centuries. Since then, we have lost our position of relative pre-eminence in industrial and economic strength; in terms of income *per capita*, for example, we now stand

only about eighth among the nations of the world. The reasons for this change are no doubt complex, but foremost among them has been our failure, over the past fifty years, to expand technological and managerial education in accordance with the real needs of the situation. This is a matter which is entirely within our own control, but unfortunately time is not on our side, and a weakness of this kind cannot quickly be made good. It is doubtful whether our rulers, or the country as a whole, are, even yet, fully aware of the seriousness of the position in which we are placed.

It seems that the western nations now have to face two possible dangers from the communist world—atomic war and industrial competition. Either threat can be met only by a great increase of technology backed by a more dynamic attitude in every field of management. For this country the message is especially urgent in view of our dependence on our export trade for our very existence. Continuous improvement in the nation's efficiency in the material sense is indeed necessary for survival, but our strength will not endure, nor will there be contentment and stability, unless there is a parallel improvement in understanding and psychological attitude. This brings us back full circle to the need for broader education, better leadership, and more enlightened management at every level. It is still true, as Napoleon said, that morale is more important than material strength.

The Greeks in their heyday proved that art, scientific philosophy and action can be united to give great results. Our own civilization can continue successfully only if it achieves a balanced combination of the humanities and technology, based on both science and art. Our need is for managers who are humanists, but who at the same time are able to understand and to use the tools of knowledge which science and technology provide.

As in the past, we in Britain can, if we will, again save ourselves by our exertions and, in addition, lead a troubled world to a fuller life by our example.

THE BRITISH CONFERENCE ON AUTOMATION AND COMPUTATION

The Institution issued the following notice to the Press on the 3rd December 1957:

'The rapid growth of automation, in which is comprised computation, process control and data processing generally, led to a decision (communicated to the Press in April 1957) by some twenty bodies of the learned society type having interests in these fields, or in their social and economic implications, to set up a central organization to provide more effective liaison between the interested bodies, to be known as the British Conference on Automation and Computation.

'This has been organized to consist of three Groups, as follows:

A. **The British Group for the Engineering Applications of Automation.**

B. **The British Group for Computation and Automatic Control.**

C. **The British Group for the Sociological and Economic Aspects of Automation Techniques.**

'At a meeting held on Friday, 20th December 1957, Group B—the British Group for Computation and Automatic Control—was formally constituted . . .*

'The objects of the Group are :

a) To foster the development and applications of automatic controls, computing and data-processing equipment and programming techniques.

b) To afford a common meeting ground for the adhering organizations whereby such of their activities as fall within the purview of the Group can, if so desired, be co-ordinated and extended.

c) To maintain, as may be desirable, liaison with other Groups of the British Conference on Automation and Computation by direct contact and by representation on the General Committee of the British Conference.

d) To encourage and, if desired, to co-ordinate the presentation at international Conferences of British papers whose subjects fall within the purview of the Group.

e) Through the General Committee of the British Conference on Automation and Computation, to maintain, as may be desirable, liaison with corresponding National Committees of other countries which support such International Conferences.

'Mr. T. E. Goldup, C.B.E. (President of The Institution of Electrical Engineers), was elected Chairman of the Group, with Messrs. J. F. Coales, O.B.E., M.A. (Society of Instrument Technology), and E. M. Renals (Institute of Cost and Works Accountants), as Vice-Chairmen.

'Mr. J. D. Green (Institute of Chartered Accountants in England and Wales) was elected Honorary Treasurer, and Mr. W. Bamford (Institution of Electrical Engineers), Honorary Secretary, and the offer of The Institution of Electrical Engineers to provide secretarial services for the Group was accepted.

'One representative of each of the following societies was elected to serve with the Honorary Officers as the Executive Committee of the Group: The British Computer Society; The Institute of Bankers; The Institute of Physics; The Institution of Production Engineers; The Iron and Steel Institute; The Office Management Association.

'The Chairman, the Honorary Secretary and one Vice-Chairman (Mr. E. M. Renals) were chosen to act as the representatives of the Group on the General Committee of the British Conference on Automation and Computation, which will also comprise representatives of the two remaining Groups now in process of formation.

'At their first meeting, the members of the Group interchanged information as to their forthcoming activities in the field of automation, and made arrangements so that the Group, and through it, the British Conference, could act as a clearing-house for information on activities of this kind.

'The meeting also reviewed current developments in the international field which fell within the scope of the Group, and confirmed the support for the International Federation of Automatic Control (I.F.A.C.), constituted in Paris in September 1957, which had been expressed at the Group's preparatory meeting. Details were received of other international associations now in being, in particular those concerned with analogue computation and cybernetics, and it was agreed to watch their progress but to take no other action in their regard, it being hoped that eventually a merger of one or both with I.F.A.C. might come about.

'Note was taken of the interest of U.N.E.S.C.O. in promoting, in 1959, an International Conference on Information Processing Methods, in pursuance of a proposal originally made by the National Joint Computer Committee of the United States in January 1957. Further details were awaited; the Group expressed their readiness, in principle, to support this project.

'The Group constitution provides for the election of additional member societies: those interested should communicate with the Honorary Secretary, B.C.A.C., Group B, c/o The Institution of Electrical Engineers, Savoy Place, London, W.C.2.'

* A list of the member societies of Group B of the B.C.A.C., which was included in the Press notice, was given on p. 47 of the January *Journal*.

THE PACKAGING OF ELECTRONIC EQUIPMENT 621.798.2 : 621.389

Much design consideration is given to the performance of electronic equipment, less to the handling it will receive when it has left the factory. Yet much financial loss could be avoided if designers were more aware of the kind of shocks their creations are heir to, and if simple tests were made to ensure that the packaging is efficient. The author, who is at the Royal Radar Establishment, describes the methods and materials used in modern packaging. The article is based on his paper of the same title published in the Journal of the Royal Aeronautical Society, 1957, vol. 61, p. 335, and the photographic illustrations are Crown Copyright.

S. C. SCHULER, ASSOCIATE

Introduction

In recent years considerable progress has been achieved in the protection of delicate equipment by suitable packaging techniques. The two main problems are moisture protection under adverse climatic conditions, and protection from mechanical shocks and vibration in transit.

Moisture can cause corrosion of mechanical assemblies and deterioration of the electrical insulation of the circuits. Protection can be achieved satisfactorily by the use of preservation treatments and/or moisture-vapour barriers, such as metal-foil laminate, polythene film or sealed metal containers, in conjunction with a suitable quantity of desiccant. These techniques are covered by a Government specification,[1] and have been found to be very effective in Service use.

The design of package cushioning to protect equipment from mechanical shock during transit and handling is a more complex problem. Although the subject has received a good deal of study, particularly in the United States by Dr. R. D. Mindlin[2] and others, there is as yet no complete theoretical treatment. The equations of Mindlin have not been adopted by packaging designers to any great extent, primarily because they are too formidable for day-to-day applications and also because they require knowledge of the stress/strain characteristics for each cushioning material; few data on these have so far been published in the United Kingdom.

To design a cushioned package satisfactorily, consideration must be given to the three main factors involved:

(1) a knowledge of the shock and vibration conditions to which a packaged equipment will be subjected in transit and handling;

(2) the breakage characteristics of the equipment to be packaged, embracing the maximum permissible accelerations, deflections and resonant frequencies of the various assemblies or components of the equipment; and

(3) data on the shock absorption, load-supporting properties and stability of cushioning materials.

Shock and Vibration Conditions during Transit and Handling

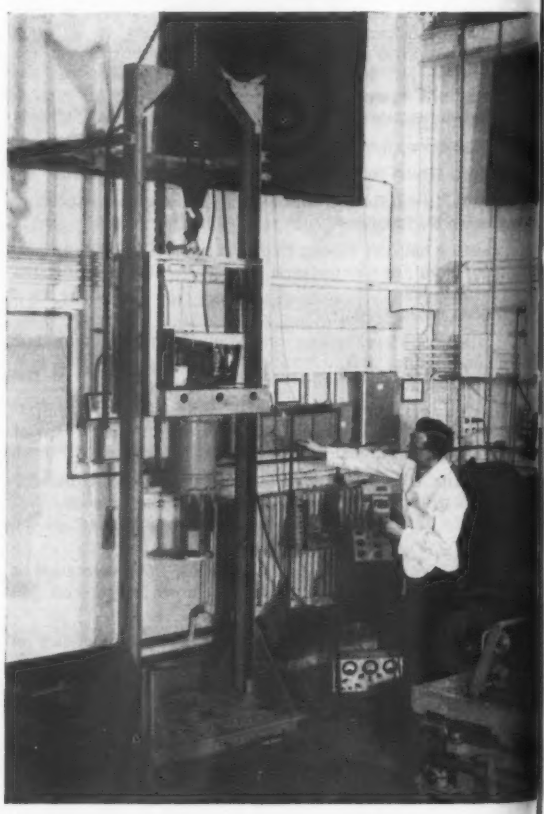
There are many types of transport which can be used for the movement of packaged equipment, and each presents its own problems and range of shock and vibration conditions.

Packages should be desig ed so that the cargo is protected when transported by road, rail, sea or air, and should meet satisfactorily the movement hazards involved in loading and unloading by slings, cranes, fork-lift trucks, man-handling and so on. Some data on the environmental conditions are contained in a Ministry of Supply specification.[3]

During loading and unloading of packaged equipment from vehicles, ships or aircraft, shocks may be experienced equivalent to a free drop from a height of 4–5 ft onto concrete. The damage which may result depends to a great extent on the amount of cushioning in the package and on the strength of the container. Experience has shown that drop hazards and mishandling are greater with lighter packages, mechanical aids being used to move the heavier loads; even with these loads, however, final positioning may be by hand and the package may well be tipped from one side to another. Trials made with the different methods of transportation show that the major shocks are invariably caused by rough handling and the drop test is therefore chosen as the main factor in test schedules to simulate handling operations.

Instrumented drop tests on electronic equipment show that large values of deceleration may be sustained at component mountings and sub-assembly locations. If a typical airborne

1 *General view of drop-test machine*



radar unit without packaging were dropped from a height of four feet onto concrete, the item would sustain a shock of approximately 1 000*g* for a few milliseconds.

A useful schedule of tests for packages is contained in the specification of Reference 1 (Part II, Section 7).

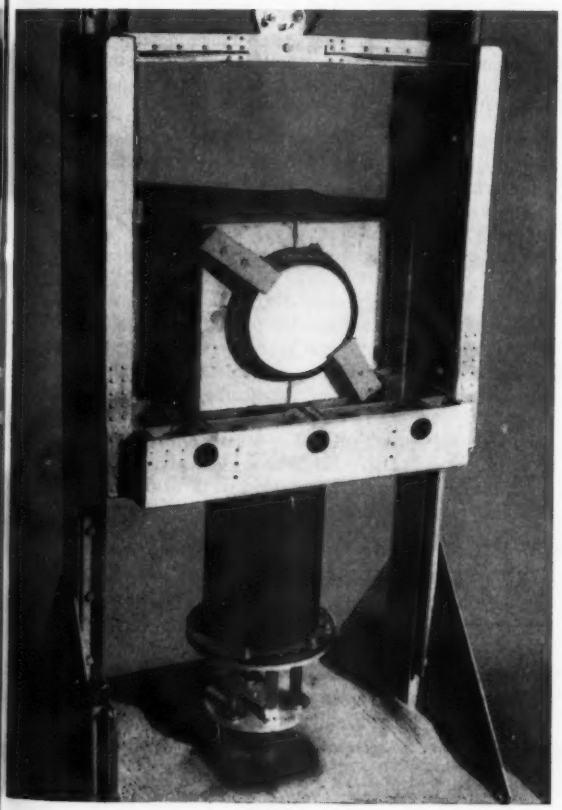
Equipment Fragility

For some items, such as simple brackets and channel and cantilever structures, the 'safe' deceleration figure (or *fragility factor*) can be determined by calculation. Most electronic assemblies are complex structures, and it is not known beforehand which are the most fragile elements. It will then be necessary to determine the breakage characteristics of the equipment by shock testing the item to reveal the weakest part of the assembly or failure of a specific component part. Moreover, a shock test is more accurate than calculation, because ductile structural materials will often endure higher deflections and accelerations under transient-shock conditions than under steady-state loads.

Drop-Testing Machine

It is necessary that the waveform of the deceleration loadings imposed during the tests should be similar to that which the packaged equipment would actually encounter under rough-handling conditions, and a deceleration-testing machine has been designed at the Royal Radar Establishment to produce a waveform suitable for this purpose.

2 *Table of the drop-test machine, showing the pneumatic cylinder underneath*



It consists of a metal carriage, about 2 ft square, on which the equipment to be tested is mounted. The table is free to move up and down between two vertical steel posts and is guided on these posts by eight steel rollers. The table is raised by means of a wire rope passing over a pulley and down to a hand- or power-operated hoist. Connection between rope and carriage is by means of a magnetically operated bomb release.

Mounted on the underside of the table is a pneumatic ram which acts as the retardation pad or cushioning. The ram consists of a cylinder and piston, air being pumped in or extracted through a Schrader valve. The intensity of the shock can be varied over a wide range: the greater the amount of air within the cylinder, the better the cushioning and the smaller the shock. Fig. 1 is a general view of the machine. Fig. 2 is a closer view of the table, on which a cathode-ray tube is mounted ready for testing. The cylinder underneath is the pneumatic ram.

The pneumatic ram will provide a peak acceleration in the range 5–90*g* with duration times in the range 10–50 millisec, variation in drop heights from 1 ft to 4 ft 6 in. and variation in table loads of up to 100 lb.

To operate the machine, the equipment is mounted on the table, which is raised to the necessary height. The ram is set up to give maximum cushioning—for example, to reduce the peak shock to, say, 10*g*. The table is released and falls onto the steel plate. The equipment is then functionally checked and inspected for mechanical failure. This procedure is repeated with gradually increasing shock intensities, until a level is reached which will cause some mechanical or electrical failure. This test is performed in both directions of each of the three main axes. The fragility factor can be used either to modify the structure so as to improve its impact strength, if this is practicable, or to calculate the required amount of cushioning in the packaging of the equipment.

Experience with the Impact Tester

Experience in testing a considerable number of equipment assemblies, cathode-ray tubes, meters, etc., has shown the following general points.

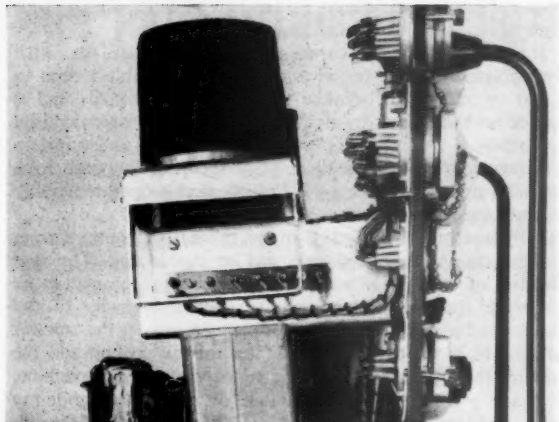
(1) It is usually the mechanical structure of electronic assemblies which shows the first signs of damage. Standard components, valves or meters rarely fail before structure.

(2) Well-designed chassis structures rarely failed to withstand shocks of 50*g* (of the kind provided by this machine).

(3) For items involving complex glass-sealing techniques (e.g. special valves, magnetrons), a number of specimens, ten or more if possible, should be used for fragility assessment. Fragility scatters of from 25–100*g* have been recorded on otherwise identical samples in this class.

Fig. 2 shows the machine set up for tests on a cathode-ray tube. A series of tests was made to establish the minimum shock required to cause permanent distortion of the gun assembly. The glass envelope was enclosed in a split wooden block and a small clearance between wood and glass was allowed all round.

This gap was filled with beeswax to accommodate dimensional differences in the sample tubes used for assessment. No measurable permanent deflection was recorded when the tube was subjected to shocks (in three planes) of up to 100*g* peak value. The fragility assessment test in this instance included operating the cathode-ray tube and measuring the



3 *Damage sustained by field test gear after a shock of 75g*

spot deflection on the face of the cathode-ray tube on impact. The damage sustained by the aluminium chassis of an item of field-test gear after a shock of 75*g* is shown in Fig. 3. The equipment was still electrically satisfactory.

It should be noted by equipment designers that cushioning a package for 40*g* protection is a reasonable proposition, but if the fragility factor falls substantially below this figure (to, say, 25*g*), the cost of the packaging and the difficulty of providing the necessary protection are very considerable. Care should therefore be taken to provide heavy components, such as transformers, with adequate strength in the fixing lugs and retaining bolts. This can generally be done without adding materially to the bulk or weight of the equipment.

Vibration

Although deceleration shocks of the type simulated above are usually the main causes of damage to equipment in transit, prolonged forced vibration can also cause important fatigue effects and damage in packaged equipment if proper vibration isolation is not provided. It is important, therefore, to determine the resonant frequencies of the structure and sub-assemblies of the equipment and of the cushioned package.

Vibrations will be transmitted through cushioning in varying degrees and will produce accelerations at the cargo equal to, less than or greater than, the external forcing acceleration.

Most airborne electronic equipments are complex structures which have many critical resonant frequencies. Those frequencies of the range encountered in transportation will have to be considered in the design of the cushioning, the type of closure and the style of construction of the outer case of the package.

If the applied vibration range of the transport vehicle excites a resonance in the structure of the cargo, or the cushioning system of the package, the severity of the vibration experienced will be considerably increased.

It is important, therefore, with packaged equipment, especially if it incorporates new techniques of cushioning, to make vibration tests before the design is approved.

General Properties of Cushioning Materials

Apart from considerations of cost and availability, the two main technical aspects of a cushioning material or system are:

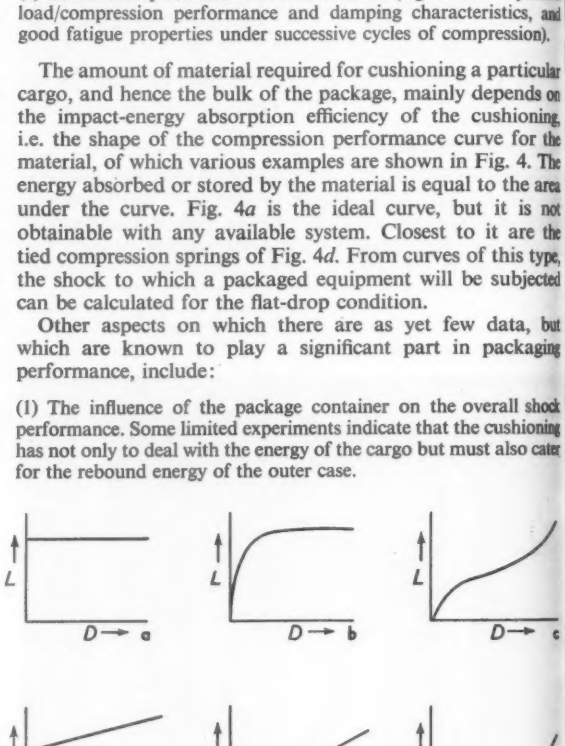
(1) general chemical and physical properties (e.g. stability under wide variations of temperature and in the presence of moisture, good ageing properties, and ease of application); and

(2) shock absorption and vibration isolation (e.g. efficient dynamic load/compression performance and damping characteristics, and good fatigue properties under successive cycles of compression).

The amount of material required for cushioning a particular cargo, and hence the bulk of the package, mainly depends on the impact-energy absorption efficiency of the cushioning, i.e. the shape of the compression performance curve for the material, of which various examples are shown in Fig. 4. The energy absorbed or stored by the material is equal to the area under the curve. Fig. 4*a* is the ideal curve, but it is not obtainable with any available system. Closest to it are the tied compression springs of Fig. 4*d*. From curves of this type, the shock to which a packaged equipment will be subjected can be calculated for the flat-drop condition.

Other aspects on which there are as yet few data, but which are known to play a significant part in packaging performance, include:

(1) The influence of the package container on the overall shock performance. Some limited experiments indicate that the cushioning has not only to deal with the energy of the cargo but must also cater for the rebound energy of the outer case.



4 *Load/compression curves for various cushioning systems*

The deflection is plotted against the load producing it. **a** Ideal curve. **b** Fine-texture flexible foamed plastic (e.g. polyurethane materials used under 'non-bottoming' conditions). **c** Coarse-texture flexible foamed plastic. **d** Tied compression springs. **e** Normal tension springs. **f** High-density rubberized hair and bonded wood-wool. **g** Medium- and low-density rubberized hair; foamed rubber.

(2) The pneumatic effect in the performance of sealed containers and bulk cushioning materials.

(3) The shape of the bulk cushioning (i.e. the effect of cavities and cut-outs in mouldings).

(4) The effect of corner and edge drops on the behaviour of cushioning materials.

When the overall plan of the package design is decided a prototype pack is prepared, and performance is checked by measuring the decelerations at the cargo (or dummy cargo) when the pack is drop tested.

Instrumentation in Packaging Investigations

In order to evaluate the dynamic performances of cushioning materials and to obtain the dynamic loadings on the cargo in packages when drop-testing, it is necessary to have available an instrument which will give a picture of the deceleration waveform. The Royal Radar Establishment have developed an instrument for this purpose comprising an accelerometer, an electromagnetic release, a delay unit and a display (with peak acceleration meter if required).

The accelerometer consists of a small barium titanate element cemented to a metal mass. Acceleration and deceleration of the unit will cause a decrease or an increase of pressure on the crystal, with consequent generation of a voltage pulse owing to the piezo-electric properties of barium titanate.

Two units have been developed, a single-plane and a three-plane type. The three-plane unit consists of three accelerometers mounted at right angles to each other; this enables drop tests to be made in three mutually perpendicular planes without the inconvenience of repositioning the accelerometer in the packing case. The three-plane accelerometer weighs 7 oz and measures $2\frac{1}{2}$ in $\times$ $1\frac{1}{2}$ in $\times$ 2 in.

The output from the accelerometer is fed through a special low-noise double-screened cable to the cathode-follower in the delay unit.

The release unit is a standard electromagnetic bomb release which has been suitably modified. The package is suspended from the jaws of the release, which can carry a maximum load of 1 000 lb. The jaws are opened by an electrical pulse fed from the delay and power unit. This remote operation ensures that the operator can stand at a safe distance from the package being drop tested.

A complete picture of acceleration pulse against time is obtained if the output of the accelerometer unit is displayed on a cathode-ray tube. For ease of measurement it is important to arrange that the peak of the acceleration pulse is always displayed at about the same point on the tube face. To achieve this, and having regard to the different time intervals which will occur between the release pulse and the impact shock for different drop heights, a variable time-delay circuit, with a control calibrated in drop heights (up to 6 ft) is provided in the delay unit. This unit also contains the cathode-follower circuit and the switch button to open the jaws of the release.

The output from the accelerometer can be displayed on a standard oscilloscope, but it is often advantageous to use one specially designed for the purpose, which makes the whole equipment self-contained. The display consists of a long-persistence cathode-ray tube of diameter $2\frac{1}{2}$ in, together with stabilized power supplies and associated circuits. The use of a long-persistence tube enables the intensity and shape of the shock waveform to be quickly assessed. For permanent records, provision is made for attaching a 35 mm single-shot camera. A calibration signal is also available, which can be switched in either immediately before or immediately after the drop test, as required.

For routine checks on standard packages, where only the maximum deceleration value is of interest, a meter which shows the peak value directly can be very useful. Facilities are available on the monitor unit to plug in a peak-reading meter assembly, which is calibrated in *g* units. The incoming signal from the accelerometer is used to charge a capacitor of long discharge time-constant. The circuit is reset to zero by means of a switch on the front panel.

Packaging Materials and Techniques

Polythene film is being used extensively for the packaging of resistors, capacitors and other small electronic spares. Each component is sealed in a polythene envelope 5 mils thick and ten components are then placed in a further outer polythene envelope. Ten such small packs go into a carton to form a bulk issue of 100 components.

Components such as vitreous-enamelled wire-wound resistors, which are rather brittle, are packed separately in a polythene envelope inside a wax-dipped spirally wound cardboard tube. Ten resistors are then arranged in a bundle secured with two rubber bands and placed, together with identification labels, in a polythene envelope of appropriate size. The bundle technique, using rubber bands, can be applied to a wide range of electronic components; it provides a most economic pack and facilitates the insertion of the components into the polythene envelope.

For equipment of irregular shape, mouldings of rubberized hair are particularly useful for package cushioning. This

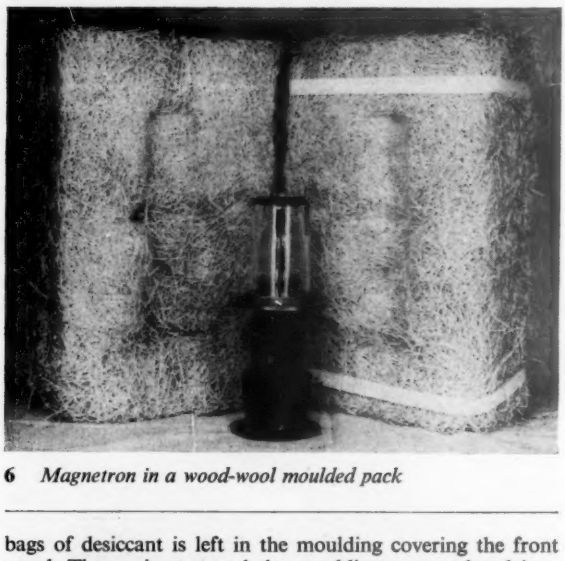
5 *The packaging of an airborne transmitter-receiver*

material is light and resilient and can be readily moulded by the use of simple wooden tools. Several firms manufacture rubberized hair, which is approved by a Ministry of Supply specification.[4]

Under the R.A.F. system of servicing, squadron workshops will not normally have sufficient trained personnel to repair sub-assemblies of radar equipment. If a fault develops, the defective sub-assembly will be removed and replaced by a new one. The defective sub-assembly will be placed in the packaging provided for the new sub-assembly and returned to the repair units. Rubberized-hair mouldings provide a convenient reusable packing material and are usually arranged so that the internal surfaces of the top and bottom blocks are moulded to conform with the profile of the sub-assembly. The top block (or lid) is provided with two recesses for locating bags of desiccant.

Where necessary, the mouldings can be hinged together with two pieces of canvas and a press stud included on the front face. An alternative arrangement for locating the two mouldings together is to form them spigot fashion so that the two halves can be held together without the use of canvas straps. The moisture barrier can be provided by a polythene film envelope which is heat-sealed over the outside of the mouldings. The whole assembly is then inserted into a suitable container.

The application of rubberized hair for the packaging of a cylindrical airborne transmitter-receiver is shown in Fig. 5. The equipment weighs 30 lb and has close-fitting mouldings of heavy-density rubberized hair to enclose the equipment in the smallest possible cylindrical shape. A pocket to receive



6 *Magnetron in a wood-wool moulded pack*

bags of desiccant is left in the moulding covering the front panel. The equipment and the mouldings are enclosed in a polythene-film bag 10 mils thick. The bag is made extra long to permit several sealings, to allow for repeated reuse.

End and girth mouldings of five-inch-thick rubberized hair form the main cushioning, and the outer container is of plywood, with reusable metal closures.

The package, including cargo, weighs 70 lb. The cushioning reduces the peak shock to 45*g*, on a free drop from a height of 4 ft 6 in onto concrete.

Moulded wood-wool is a useful material for packaging certain types of electronic valve. The moulding is made from

7 *Tied compression springs*

shredded wood cuttings, usually of spruce, which are dried and then bonded together with urea formaldehyde under pressure. Fig. 6 shows a 17 lb magnetron with its conforming wood-wool moulded pack. The mouldings spread the loads on impact over the whole surface of the valve and minimize local stresses on the glass boot. It is important that the item should first be sealed in a polythene bag before insertion in the mouldings to prevent any possibility of corrosion.

Wood-wool mouldings are considerably cheaper than other moulded cushioning materials, and, although stray curlings break off, this is not a disadvantage for valve packaging. Assembly of the package is very simple and represents a considerable saving in packaging time; the whole arrangement is considerably cheaper than the spring-crate type of package which has often been used for valves of this type. Low-density mouldings have the disadvantage of marked fatigue under repeated impact loadings. Wood-wool mouldings are not recommended for reusable packaging applications, but this is not usually a requirement for valve packaging. For certain applications it may be desirable to have a high-density conforming wood-wool moulding as the inner pack, surrounded by shock-absorbing pads of low-density wood-wool or rubberized hair.

A range of pre-compressed-spring shock absorbers is available. A typical shock absorber employs eight springs under high compression, an arrangement which results in the high energy-absorption characteristics referred to above and provides a material saving in dimensions and packaging. The weight of the standard unit is 11·5 oz, and its dimensions are 2 in × 6½ in × 3 in. The standard unit can be clamped to form a double or triple assembly to give greater protection to the item being packaged.

The shock absorbers are attached to an outer case, usually by wood screws, and a typical application is shown in Fig. 7. Here the equipment weight is 60 lb and the two banks of spring pads reduce the shock to 30*g* when the package is dropped from a height of 3 ft onto concrete. The pads are rather difficult to apply to cylindrical cargoes, and they require a stout outer case because loads are confined to small areas of the case.

Summary

The satisfactory packaging of delicate electronic equipment is often a complex problem, but it can be considerably eased

if designers of equipment incorporate features which will assist the packaging design, for example:

(1) Provide mounting of adequate strength for heavy components, and reduce to a minimum projecting assemblies on the external faces of the equipment.

(2) Provide adequate pick-up points or mountings on equipment which can sustain the dynamic loads under impact.

(3) Wherever possible determine the fragility factor of the equipment by a series of tests on a drop-test machine, and if necessary, introduce simple modifications to improve the strength factor of assemblies under these conditions.

After a prototype package has been made, instrumented drop tests should be carried out to check that the required protection is being realized in practice.

Attention to the points outlined will facilitate efficient packaging designs and ensure safe shipment of valuable equipment under adverse conditions of handling, transit and store.

References

1 'General Requirements for Packaging Supplies for the Services' Ministry of Supply Specification No. DEF. 1234 (H.M.S.O., 1954).

2 MINDLIN, R. D.: 'Dynamics of Cushioning', Technical Monograph No. B.1369 (Bell Telephone Laboratories, 1945).

3 'Climatic and Durability Testing of Service Telecommunication, Equipment', Ministry of Supply Specification No. K.114 (Radio Components Standardization Committee, 1950).

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U.H.F. TRANSMISSIONS FROM CRYSTAL PALACE

On the 11th November 1957 the B.B.C. began a series of high-power test transmissions on 654·25 Mc/s to collect further data on the u.h.f. bands (Bands IV and V*), which were allocated to television at the International Radio Conference at Atlantic City, 1947, but have not so far been used for television broadcasting in this country.

After earlier laboratory work, the B.B.C. embarked on their first series of u.h.f. propagation measurements in 1955. These were directed towards the investigation of propagation on frequencies in the range 470–960 Mc/s over distances representing a normal service area, and over longer distances to obtain data necessary for the evaluation of co-channel interference. The initial tests were for the latter purpose and employed transmitters modulated by square waves. The transmitters were installed at various television transmitting stations, the aerials being erected high up on the television masts. Regular field-strength measurements have been made over long periods at various locations, some as far away as the Shetland Islands.

The long-distance tests were followed, in 1956, by a series to determine propagation conditions within a typical service area, using a transmitter at the Crystal Palace on 495 Mc/s, working into a Yagi aerial and radiating a peak power of 1 kW over a fairly narrow beam when modulated with square waves; pulse modulation was also used for some of the tests. The bearing of the aerial was changed from time to time so that field strengths could be measured in all directions from Crystal Palace.

However, the information collected in this way was insufficient, and at the request of the Television Advisory Committee the B.B.C. decided to embark on a more ambitious series of experiments, using a high-power transmitter and radiating full television signals, initially on 405 lines and later on 625 lines (C.C.I.R. standards).

For this purpose the B.B.C. have installed at Crystal Palace a 10 kW peak-white u.h.f. vision transmitter, the vision frequency being 654·25 Mc/s, and a sound transmitter with a carrier power of 2½ kW. The equipment is low-power modulated on both sound and vision channels. The klystrons employed in the audio and video final stages use three external cavity resonators and operate as linear amplifiers with a power gain of approximately a hundred. They are driven by a modulated amplifier stage operating with a cathode-modulated circuit. The output of the transmitters is combined in a circuit of the filter bridge type, constructed in rectangular-section waveguide. The combined output is then conveyed to the aerial by an elliptical waveguide measuring 12 in × 6 in. At the top of the 700 ft television mast the waveguide is transformed into a 5 in concentric feeder to take power to the helical aerial. This comprises four bays mounted one above the other on the same vertical axis, each having a linear height of five wavelengths. Each bay is fed at the centre, the helix being wound from the centre point of the bay in opposing directions to cancel the vertical component of radiation. The aerial has a power gain of 20, and the effective radiated power of the vision signal is 125 kW peak white in the horizontal plane.

The Band V transmitter is in operation for several hours a day, radiating pictures on the 405-line standard. The pictures are the same as those radiated by the Band I transmitter installed in the same building. Later, pictures on 625 lines will be produced at Lime Grove from flying-spot telecine equipment and sent over a specially equipped coaxial cable to Crystal Palace. The tests on 405 lines will continue until about March 1958. The transmitter will be readjusted and a second series of tests will then begin on 625 lines. For these latter tests the programme will usually be different from that being radiated by the Band I transmitter, but at certain times duplicate copies of films scanned on the two systems will be radiated simultaneously.

The B.B.C., the radio industry, the Post Office, the D.S.I.R. and the I.T.A. are organizing comprehensive studies of the received pictures. A number of experimental receivers of various types will be used, some being representative of the designs that might be expected to become available to the public in the future. The B.B.C. hope that the information gained from these tests will prove useful when the Television Advisory Committee prepare their recommendations on the future development of television in the United Kingdom. In particular they would throw light on the effects of a possible change in the U.K. television standards to conform with those on the Continent. There is no intention of making any change in the 405-line standards used at present for television broadcasting in Bands I and III.

* Band IV is the frequency range 470–585 Mc/s.
Band V is the frequency range 610–960 Mc/s.

SATELLITES 621.396.946

Russia and the United States had previously announced their intentions of creating earth satellites as part of the International Geophysical Year, but the actual launching of the first Russian one took the world by surprise, perhaps because it was one of those projects that seem fantastic until they happen. The reaction, however, was immediate, and in the next few weeks many observations were made on both satellites. An extraordinary meeting of the Radio and Telecommunication Section on the 22nd November 1957 gave British scientists and radio engineers an opportunity to discuss their results—the majority involving radio techniques. Now that the Americans have successfully established their first earth satellite, interest will quicken in the scientific uses of these new planetary instrument carriers.

As might be expected, such a topical subject as *Radio Observations on the Russian Satellites* attracted a very large audience to the special afternoon and evening meeting of the Radio and Telecommunication Section held on the 22nd November. Three representatives from the Russian Embassy were amongst those who heard reports of observations made in this country by a surprisingly large number of people and organizations. An unusual, if not unique, feature of the meeting was the newness of the material presented, for the subject of the observations had not even existed seven weeks before.

In an introductory talk Dr. R. L. F. Boyd spoke of the earth satellites as a great achievement and said that the launching of the first satellite was undertaken to test the effectiveness of the radio link between the satellite and the ground, to obtain data on the shape of the earth by means of observations on the orbit, and to discover the drag of the atmosphere on the satellite itself.

The second satellite probably consisted of a similar vehicle, but the sphere containing the transmitter was not ejected. Its primary purpose was apparently to discover something about the hazards of space travel, especially the effects on a dog of acceleration, prolonged weightlessness and bombardment by cosmic rays. This satellite also contained instruments for measuring the flux of cosmic rays and the flux of ultra-violet light.

Satellites are invaluable, of course, for purely geophysical studies concerning the density, temperature and composition of the upper atmosphere, the ionization beyond the peak of the F layer, the shape of the earth, the distribution of land masses, and the problems of geomagnetism. They could be of great help in meteorology and in stellar spectroscopy, particulary of those regions of the spectrum which are absorbed by the atmosphere.

Dr. Boyd next considered the forces acting on the satellite, for, besides the gravitational forces of the earth and its land masses, the sun and moon and other celestial bodies, there is electromagnetic damping of the satellite's rotation by eddy currents, and an electrostatic drag due to the charging of the satellite (by photo-emission under the ultra-violet irradiation) and the consequent trailing after it of a space charge of particles of opposite sign.

With the aid of an excellent model, Dr. Boyd enumerated the principal elements of the orbit. They are:

(1) the minimum height of the satellite above the earth (height at perigee),

(2) the maximum height (height at apogee),

(3) the position of the intersection of the orbital plane with the equatorial plane,

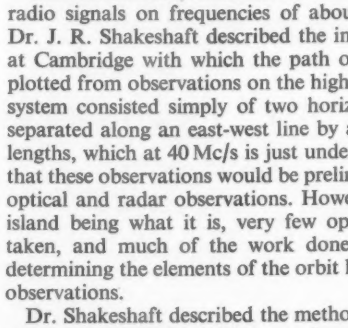
(4) the angle which the line joining the apogee and perigee makes with the equatorial plane, and

(5) the inclination of the orbit, i.e. the angle between the orbital plane and the equatorial plane.

He concluded by saying that radio measurements can assist in the determination of these parameters and their variation with time.

The first satellite, launched on the 4th October, transmitted radio signals on frequencies of about 20 and 40 Mc/s, and Dr. J. R. Shakeshaft described the interferometer equipment at Cambridge with which the path of the satellite had been plotted from observations on the higher frequency. The aerial system consisted simply of two horizontal full-wave dipoles separated along an east-west line by a spacing of four wavelengths, which at 40 Mc/s is just under 100 ft. It was intended that these observations would be preliminary to more accurate optical and radar observations. However, the climate of this island being what it is, very few optical photographs were taken, and much of the work done at Hurstmonceaux in determining the elements of the orbit has been based on radio observations.

Dr. Shakeshaft described the methods used to establish the orbit of the satellite, which was found to be nearly circular with an inclination of 65° and a period of about 96 minutes (Fig. 1). Measurements of the apparent changes of frequency



1 *The orbit of the first satellite with respect to Cambridge*

The angle of inclination of the orbit is 65°, and Cambridge moves relative to the orbit along the small circle, latitude 52° 12′. The positions of Cambridge at three successive times of transit of the satellite across this latitude are marked. The 40 Mc/s signals enabled the satellite to be detected at a range of about 2 000 km, and so seven transits out of the daily fifteen could be observed. As the satellite slows down, the height at apogee decreases more rapidly than the height at perigee, and the orbit tends to become more circular.

due to the Doppler effect also helped in the derivation of the orbit. The period of 96 minutes was decreasing at about 2 sec/day, corresponding to a change in the semi-major axis of about 315 km/day.

The fading of signals was thought to be caused by the

rotation of the satellite at 6·8 r.p.m. and by the Faraday effect, i.e. the rotation of the plane of polarization of the transmitted wave in the ionosphere due to the earth's magnetic field.

The transmitter in the first satellite lasted three weeks but that in the second only five days. The period of the second satellite is about 103 minutes, and its orbit is more elliptical than that of the first, having the same perigee but an apogee of about 1 600 instead of 900 km.

Mr. A. N. Beresford told of similar measurements made at the Royal Aircraft Establishment. The interferometer had a four aerial system, one pair of dipoles lying approximately north and south and the other pair accurately at right angles. As with the Cambridge apparatus, the spacing of each pair was 100 ft. The average heights of the first satellite calculated from the observations were 250 n. miles for the morning transits and 130 n. miles for the evening transits.

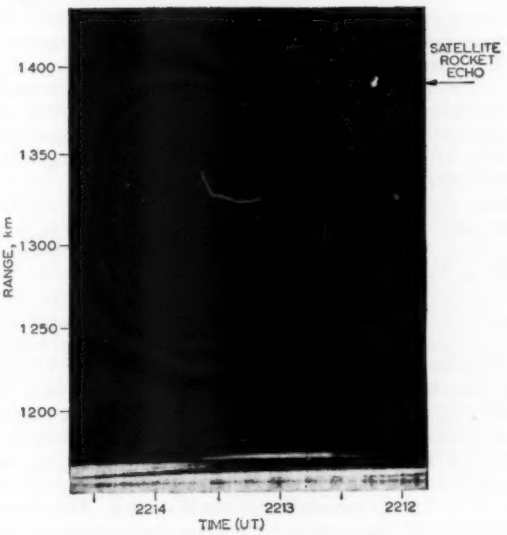
Accounts of observations made on conventional direction-finders were then given by Mr. F. A. Kitchen (at the Admiralty Signal and Radar Establishment) and Dr. W. C. Bain (at the Radio Research Station). Both remarked on the unexpectedly long time during which the signals were heard on each orbit; on one occasion the approaching satellite was first heard as it passed over the region of Montevideo. A puzzling feature, however, was that while the signal was heard for a long time on the approach, it was not heard for very long on the recession. It was not known whether this asymmetry was due to an ionization effect in the F region. Since the transmitter was of very low power, estimated to be about 1 watt, Mr. Kitchen was interested in how the long-distance propagation was effected. He proposed two possible mechanisms: first, conventional multi-hop propagation between the earth's surface and the atmosphere, and secondly propagation within the boundaries of the F region or between the E and F regions, which might act as a leaky waveguide excited by the satellite transmitter. But it was not clear how either mode could be initiated at such long range, especially since the satellite itself was probably above the F region, which was at that time fairly dense.

Dr. Bain said that signals had been received at Slough when the first satellite was on the far side of the North Pole, and he pointed out that in this instance the long-distance propagation occurred when the satellite was at a height below the F_2 maximum.

The general discussion, which was somewhat slow in starting, produced a statement that the predicted orbits agreed with the measured ones to within the limits of experimental accuracy. Mr. G. Millington, who claimed the distinction of being the first speaker not to have made any observation on the satellites, spoke of the possibility of round-the-world echoes from a transmitter situated in such an advantageous position. Mr. Kitchen was able to add that some evidence of such echoes had been detected on direction-finders. The meeting then adjourned for tea, and attention was temporarily diverted from outer space to inner space.

The evening session was opened by Mr. H. Stanesby, who gave details of the Doppler frequency measurements made at Banbury and Baldock. He showed plots of received frequency against time which exhibited a characteristic decrease as the satellite passed the observing point, the maximum rate of change occurring at the time of closest approach. A very interesting feature of these curves, which was referred to by several speakers in the discussion, was the false start to the frequency drop observed about five minutes before the main decrease. Mr. Hampton also spoke of Doppler measurements at Farnborough and of the methods of analysis by which times and distances of nearest approach were calculated to a high degree of accuracy. The field-strength records presented by Mr. P. N. Parker showed that one of the characteristics of the signals from Sputnik I was a regular fading in intensity, which had a period of about 10 sec. The estimated power radiated from the first satellite was about 2 watts at 40 Mc/s and rather less than 1 watt at 20 Mc/s.

Attention was then turned to the part played by radar, and Mr. J. S. Greenhow described how both satellites had been observed on the large radio telescope at Jodrell Bank. Dr. J. S. Hey showed some interesting photographs of echoes he had received from the first satellite rocket on the 30th October, using a 45 ft-diameter radio telescope at the Royal Radar Establishment, and he emphasized the difficulty of finding such a target with a beam subtending only half a degree. One such photograph is shown in Fig. 2.



2 *Radar echo of the rocket of the first satellite*
Royal Radar Establishment, Malvern, 30th October 1957.

In the subsequent discussion, which was more lively than that of the afternoon, the anomalies observed in the Doppler frequency records and the fading of the signal strength were the main subjects, and explanations in terms of propagational effects and rotation of the satellite were put forward by several speakers.

An interesting contribution was that made by Mr. H. V. Griffith, who played a tape recording of the 'bleeps' in order to illustrate the change in Doppler frequency as the satellite passed by. Another recording, made just before the transmissions ceased, showed how the character of the 'bleeps' had changed since they were first heard.

Summing up the meeting, Dr. R. L. Smith-Rose reminded the audience that the launching of the satellites was part of the programme for the International Geophysical Year and that the primary purpose was the exploration of the upper atmosphere and the measurement of solar radiation. He sounded a note of warning to those who might belittle the influence of the ionosphere on the accuracy of their measurements; we

(*continued on p.* 110)

CORRESPONDENCE

TRANSIENT EFFECTS DUE TO SHORT-CIRCUITING OF ALTERNATORS

From J. S. VOSPER, B.SC.(ENG.), ASSOCIATE MEMBER*

The exponential decrement of the a.c. component of the short-circuit current of an alternator is well known to contain two terms of different time-constants, namely T'_d, of the order of several seconds (referred to as 'transient') and T''_d, of the order of a few hundredths of a second (referred to as 'sub-transient'). Terms of shorter time-constant are also known to exist, and although, as pointed out by Tompsett†, they have no practical significance for short-circuit current magnitudes, they are important in other respects, particularly for restriking voltages. In a recent discussion before the Measurement and Control and the Utilization Sections‡ the existence of several time-constants in electrical machines received considerable attention.

When a short-circuit current is interrupted (at natural current zero) the terminal voltage is initially low, reaching its open-circuit value exponentially with two time-constants similar to those evidenced in the current wave. Unlike the current wave, however, the voltage, owing to the very low power factor, starts at approximately 90° along its waveform.

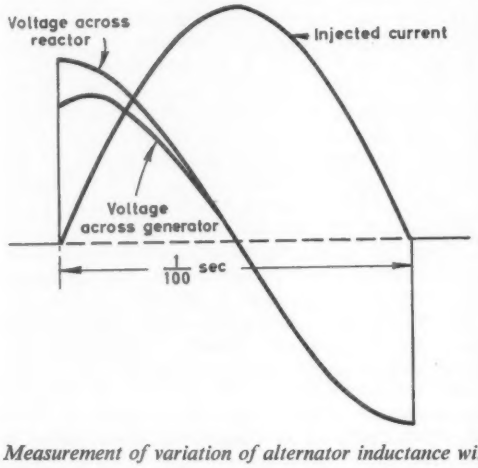
It was pointed out by C. E. R. Bruce twenty years ago§ that the actual value of this first peak of the recovery voltage wave may be appreciably less than that which would be expected by extrapolation from the subsequent peaks, using the two exponential terms referred to. In fact he deduced that during the first quarter-cycle the voltage approaches the expected sinusoid exponentially with a time-constant of the order of a few milliseconds (see the diagram). The recent confirmation of these results by modern cathode-ray oscillograph recording is a tribute to the painstaking care with which the early oscillograms (taken by means of Duddell electromagnetic oscillographs) were analysed.

It has recently been required to devise a method whereby this phenomenon (with the time-constant of the order of a few milliseconds) could be indicated without recourse to full-scale short-circuit tests. The method of measurement adopted for this purpose, whilst not novel, is relevant to the present discussion and will be briefly described below.

The principle is that of current injection. A half-rectified sine wave of current (at 50 c/s), with a peak value of the order of a fraction of an ampere, is injected into a circuit consisting of the generator (single phase, line-line) in series with an air-cored heavy-current reactor of comparable and known reactance. The voltage across the generator, recorded on an oscillograph, is compared with that across the reactor. The voltage across the reactor is for all practical purposes a good cosine wave, corresponding to a constant inductance, and can therefore be used for calibrating. The voltage scale is a measure of inductance, and a comparison of the waveforms therefore indicates the way in which the generator inductance varies during this interval of time (namely 1/100th sec).

It is of particular interest to note that the waveform of the voltage developed across the generator in this low-current test is in very good agreement with that obtained in the live test. A typical result is illustrated in the diagram.

An important requirement in this measurement is the faithful reproduction of a sinusoidal current, especially during the first quarter-cycle. This was obtained successfully from the veteran Restriking Voltage Indicator described by Trencham and Wilkinson* in an Institution paper in 1937, although working outside the time intervals for which it was designed. The addition of a cathode-follower output stage to increase the output impedance for the larger modern machine has proved satisfactory.



Measurement of variation of alternator inductance with time

It is evident from these measurements that the flux was confined to the stator, and that, at these very low currents and in the absence of excitation of the main field, the inductance is rather higher than the sub-transient value deduced from the first half-cycle of current in a full-scale short-circuit test. It is known from previous work† that excitation of the main field reduces the reactance measured in the above manner.

It is interesting to note that this particular phenomenon probably corresponds to the early portion of the curve D in Tompsett's communication, referred to above. The magnitude of this component may well vary with details of stator design, and it should be noted that the measurements referred to above were made on a 'tunnel-wound' machine. A similar effect of comparable magnitude has, however, been observed in a machine with open stator slots; but these slots may approximate to the tunnel type in that they are deep.

* Mr. Vosper is with the Electrical Research Association. His letter was received on the 20th December 1957.

† *Journal I.E.E.*, 1957, 3, p. 274.
‡ Discussion on 'The Measurement of the Dynamic Characteristics of Electrical Machines', 19th November 1957.
§ E.R.A. Report Ref. G/T87: 1938.

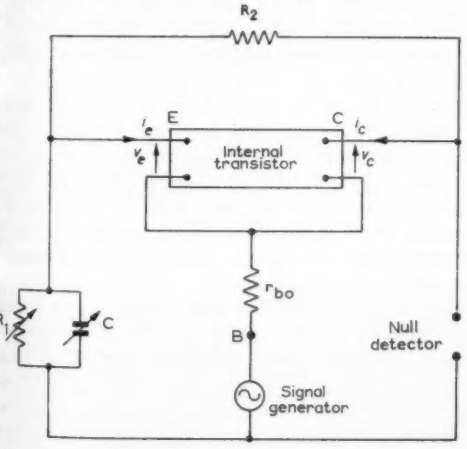
* *Journal I.E.E.*, 1937, 80, pp. 460–468.
† *Ibid.*, pp. 468–469 (Discussion).

SHORT REVIEWS OF PAPERS

Measurements on Commercial Transistors

A short review of a Radio and Telecommunication Section paper (No. 2438) entitled 'Some Measurements on Commercial Transistors and their Relation to Theory', by F. J. Hyde, M.Sc., Associate Member. The paper was published in January 1958 in Part B of the Proceedings. The author is at the Radio Research Station.

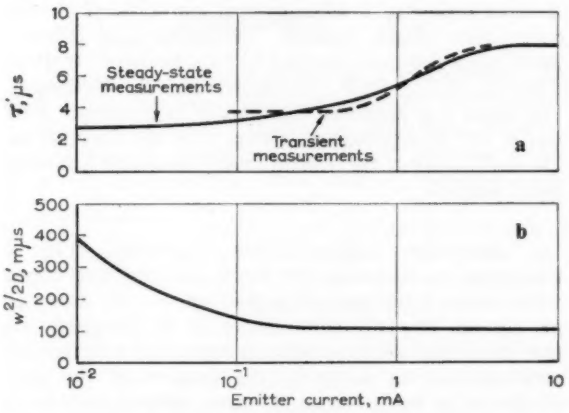
WHEN DEVISING A THEORETICAL EQUIVALENT CIRCUIT FOR the diffusion-type transistor it is common practice to take as the starting-point the analytical results for one-dimensional diffusive transport of minority carriers across the base. Now it is not reasonable to expect that the practical transistor can be considered as a one-dimensional device. The dimensions are finite and small, so that the surface of the base must play some part, albeit a small one, in determining the properties of the 'internal' transistor; that is, it must be considered as a three-dimensional device. A three-dimensional analytical treatment is much more complicated than a one-dimensional analysis and has the considerable disadvantage of dependence on the particular geometry involved. On the grounds of expediency, therefore, it is of interest to know how closely a practical transistor can be represented by the ideal one-dimensional model, and in consequence by the 'theoretical' type of equivalent circuit. With this end in view the author has studied several commercial alloy-type and surface-barrier-type transistors.



1 *A.C. bridge used for measurements of real and imaginary parts of α_{cb} at low frequency*

The internal transistor is the complete transistor less the ohmic base resistance r_{bo}.

Three basic parameters which govern the transport of minority carriers across the base of the ideal transistor are the active base width w, the bulk diffusion constant D for minority carriers and their bulk lifetime τ. For each practical transistor w has been taken as constant, while the symbols D and τ, wherever they occur in the one-dimensional analysis, have been credited with effective values D' and τ', to take account of surface scattering and surface recombination respectively. In addition D' and τ' also include the dependence of D and τ on the density of injected minority carriers in the base.



2 *Characteristics of an alloy-junction transistor*

a Variation of τ' with emitter current.
b Variation of $w^2/2D'$ with emitter current.

Values of the complex low-frequency base-to-collector current gain α_{cb}, determined by means of the bridge circuit of Fig. 1 (C and R_1 are variable and R_2 is a 10-ohm resistor), lead to values of D' and τ' when the balance condition of the bridge is analysed in terms of the modified one-dimensional theoretical expression for α_{cb}. The value of τ' was also determined independently, from the transient decay of the emitter-to-base voltage, subsequent to the cutting-off of emitter current. Specimen results for an alloy-junction transistor are shown in Fig. 2, in which the abscissa is emitter current. In Fig. 2*a* the dashed curve represents τ' measured by the transient method, and the solid curve represents corresponding values of τ' derived from the steady-state measurements. In Fig. 2*b* the variation of $w^2/2D'$ is shown. Using the values of $w^2/2D'$ and τ' so determined, the author calculated the so-called cut-off frequency of the internal

current gain (a high-frequency parameter) and compared it with that determined from measurements at high frequency. For alloy-type transistors there was reasonably good internal consistency between these two values, and it was concluded that the macroscopic results of one-dimensional theory could be regarded as applicable to such transistors. For surface-barrier transistors agreement was poorer for two reasons: (i) the emitter efficiency of this type of transistor is rather low, and (ii) the boundaries between the emitter and base and collector and base are markedly curved. 621.382.333 : 621.317.61

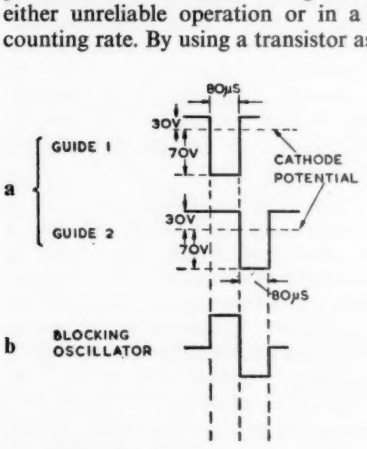
Transistor Drives for Dekatrons

A short review of a Measurement and Control Section paper (No. 2440) entitled 'Dekatrons and Electro-Mechanical Registers operated by Transistors', by G. B. B. Chaplin, M.Sc., Ph.D., Graduate, and R. Williamson. The paper was published individually in November 1957 and it will be republished in Part B of the Proceedings. The authors are at the Atomic Energy Research Establishment, Harwell.

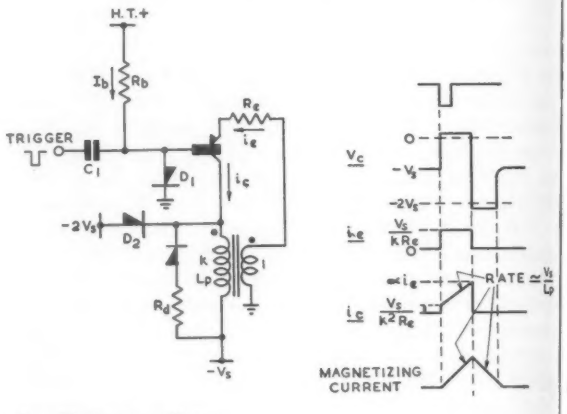
THE DEKATRON COLD-CATHODE COUNTING TUBE IS recognized as a convenient device for counting events which occur at a maximum rate of up to a few thousand per second. The two main reasons for its popularity are that it consumes little power and it provides a convenient indication of the count by the position of the glow discharge. Its performance, however, depends very much on the method of driving it. Although thermionic-valve driving circuits can generate the correct waveforms, the high-power dissipation is inconvenient and can adversely affect the reliability of the other components. On the other hand cold-cathode tubes dissipate little power but produce far from ideal driving waveforms, resulting in either unreliable operation or in a reduced maximum counting rate. By using a transistor as the driving device, reliable operation can be obtained at the maximum counting rate and with low power dissipation.

The waveforms required by the Dekatron are shown in Fig. 1*a* and consist of two pulses, each of 100 volts amplitude and 80 microsec duration, which are applied to the two guide connections of the Dekatron. There should be no gap between the two pulses but rather some overlap. Since most transistors will not stand collector voltages greater than 30 volts, a transformer is used to generate the 100-volt pulses, and it is then convenient to use the same transformer as the feedback element in a trigger circuit of the blocking-oscillator type. If the waveform of Fig. 1*b* can be generated in the blocking oscillator it should not be difficult to derive the two guide waveforms from it.

The blocking oscillator of Fig. 2 produces a collector waveform V_c of the required shape. The duration of the positive half-cycle is determined solely by the transformer inductance and R_e, and the duration of the negative half-cycle is controlled by the potential to which the diode D_2 is returned, since the areas of the V_c waveform above and below the datum line $-V_s$ must be equal.



1 *Guide and blocking-oscillator pulses*
a Specified guide pulses of Dekatron.
b Blocking-oscillator pulse.



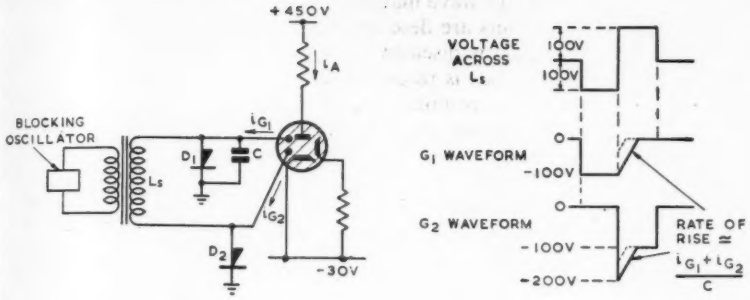
2 *Blocking oscillator*

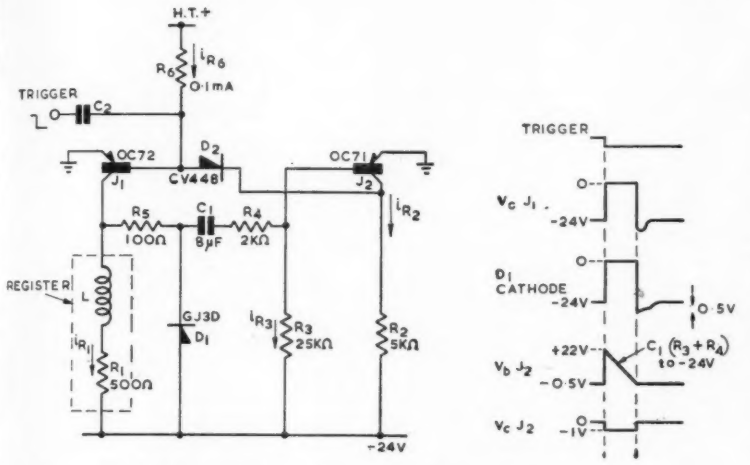
Two diodes and a condenser are used to generate the two guide pulses from the blocking-oscillator waveform as illustrated in Fig. 3. The resulting pulses differ from those specified in Fig. 1 by the negative spike in the guide 2 pulse, which is, however, beneficial in transferring the glow discharge from guide 1 to guide 2 and ensures sufficient overlap of the pulses.

A useful feature of the transistor drive circuit is that the delay between an input pulse and the resulting carry output pulse does not include the duration of the guide pulses but consists only of the triggering time of the transistor, which is a few microseconds. Thus, if several Dekatrons are cascaded, the carry is propagated rapidly, resulting in increased accuracy when the Dekatrons are used for timing applications such as frequency division.

For counting maximum input rates of less than 10 per second an electro-mechanical register is attractive since

3 *Guide connections*





4 *Monostable trigger circuit for electro-mechanical register*

it contains four decades. A typical register requires a pulse of 24 volts at 50 mA and of 1/10th second duration to actuate the electro-mechanical ratchet and hence add one to the count. In the monostable cross-coupled circuit of Fig. 4 the register is in the collector circuit of J_1, which is normally non-conducting. A trigger pulse causes J_1 to conduct for a time determined by C_1, R_4 and R_3.

In both this and the Dekatron circuit the transistor is bottomed when conducting and so dissipates only a few per cent of the power consumed by the load.

5 *Power pack containing three Dekatron decade units*

Fig. 5 shows a mains-operated power pack into which are plugged three out of a possible five Dekatron decade units. The main chassis is fitted with a switch for resetting the Dekatrons and a three-way switch for normal counting or applying test pulses from a built-in oscillator.

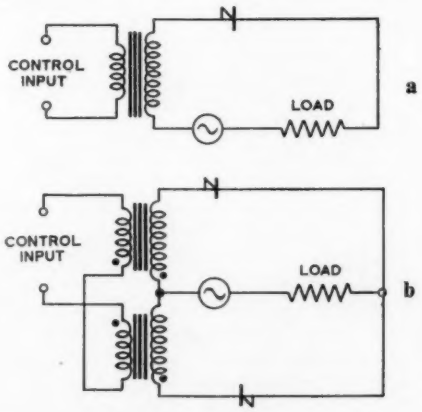
Several Dekatrons which failed to operate in a unit driven by cold-cathode valves functioned correctly in the transistor unit, and experience so far confirms the expectation of high reliability.

621.374.32 : 621.385.12

Half-Wave Magnetic Amplifiers

A short review of a Measurement and Control Section paper (No. 2353) entitled 'Some Aspects of Half-Wave Magnetic Amplifiers', by G. M. Ettinger, B.Sc. (Eng.), M.Sc.(Eng.), Graduate. The paper was published individually in April 1957 and it will be republished in Part B of the Proceedings. The author was formerly with Air Trainers Ltd., and is now with the English Electric Co.

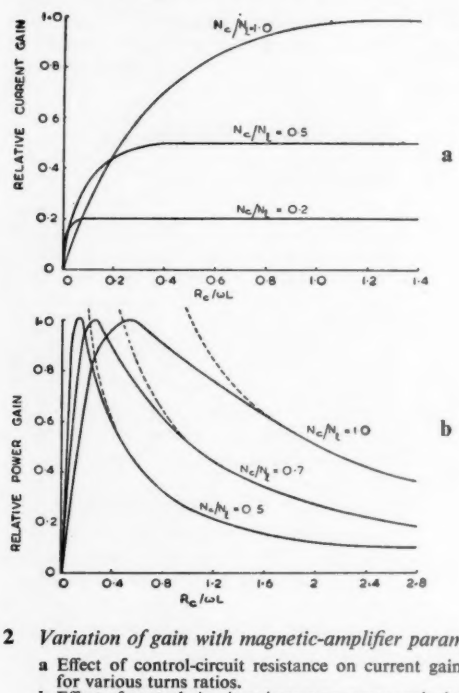
HALF-WAVE MAGNETIC AMPLIFIERS ARE finding increasing applications in servo systems. They have fast response, but their sensitivity is affected by control-circuit resistance, rectifier leakage and imperfect core saturation. In his paper the author considers these effects and develops expressions for optimum turns ratio. He defines a *reset factor* which relates the gain of half-wave and full-wave magnetic amplifiers, and he shows that the maximum possible



1 *Magnetic amplifier circuits*
a Half-wave. b Full-wave.

power gain of a half-wave magnetic amplifier is a function merely of the load-circuit Q-factor. Finally, he describes various bias circuits and gives details of a conductance-controlled magnetic amplifier.

Operation of magnetic amplifiers depends on the reset or decrease of magnetic flux from saturation to a value determined by the control current. In half-wave magnetic amplifiers (Fig. 1*a*) this decrease is opposed by currents induced in the control circuit. Therefore, the current gain falls as the control-circuit resistance is reduced (Fig. 2*a*),



2 *Variation of gain with magnetic-amplifier parameters*

a Effect of control-circuit resistance on current gain (computed) for various turns ratios.

b Effect of control-circuit resistance on power gain (computed) for various turns ratios. Broken curves show power gain of corresponding full-wave magnetic amplifiers.

and the power gain passes through a maximum as indicated in Fig. 2*b*. In full-wave magnetic amplifiers (Fig. 1*b*), on the other hand, the control current can be established over several cycles, so that the effect of control-circuit resistance is less serious. Analysis and experiment show the effects of reverse resistance of the self-excitation rectifiers to be qualitatively similar to those of control-circuit resistance.

Increasing load-circuit phase angle reduces the time which is available during each cycle for reset. Since the permeability of 'square-loop' core materials remains much greater than unity when saturation has been reached, magnetic-amplifier load circuits are inductive, even where the external load is purely resistive. Imperfect core saturation leads, therefore, to a reduction of the sensitivity of half-wave magnetic amplifiers and must be considered in the computation of gain.

The author considers various means for providing bias in half-wave magnetic amplifiers. Both d.c. and a.c. bias circuits are described, their effect on line-voltage dependence is discussed and a technique termed *part winding a.c. bias* is recommended for highest gain.

The complete expression for the current gain S of a half-wave magnetic amplifier with perfect rectifiers is shown to be

$$S = \frac{1}{2\pi}\frac{N_c}{N_l}Q_l\left\{1 - \exp\left[-\frac{(\pi-\theta)R_c}{\omega L N_c^2/N_l^2}\right]\right\} \quad . \quad (1)$$

which reaches a maximum of

$$S_{max} = 0{\cdot}18\sqrt{(R_c/\omega L)Q_l} \quad . \quad . \quad . \quad (2)$$

where N_c and N_l are control and load turns, Q_l is the unsaturated load-circuit magnification, ωL is the load-circuit reactance, θ is the saturated load-circuit phase angle and R_c is the control-circuit resistance. It follows from eqn. (2) that the maximum power gain A_{max} of a half-wave magnetic amplifier is given by

$$A_{max} = 0{\cdot}032Q_l \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Allowance for a rectifier leakage resistance R_d several times greater than the load-circuit reactance may be made simply by writing for R_c in equations (1) and (2) an effective resistance equal to the parallel connection of R_c and the reflected value of R_d.

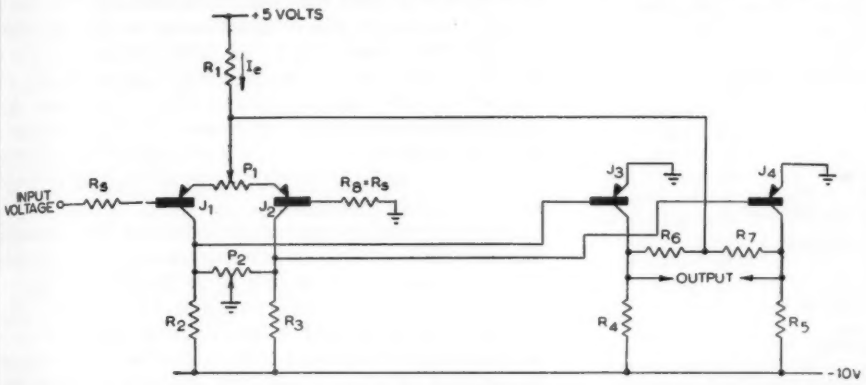
Expressions developed in the paper for magnetic-amplifier gain in terms of rectifier and control-circuit properties are compared with experimental results for magnetic amplifiers wound on HCR metal, Mumetal and Permalloy F cores. 621.375.3

Transistors in High-Gain D.C. Amplifiers

A short review of two Measurement and Control Section papers (Nos. 2382 and 2442) entitled 'Some Transistor Input Stages for High-Gain D.C. Amplifiers' and 'A Transistor High-Gain Chopper-Type D.C. Amplifier', by G. B. B. Chaplin, M.Sc., Ph.D., Graduate, and A. R. Owens, M.Sc., Graduate. The papers were published individually in July and November 1957, respectively, and they will be republished in Part B of the Proceedings. The authors are at the Atomic Energy Research Establishment, Harwell.

IN MANY APPLICATIONS IT IS A RELATIVELY SIMPLE PROCESS to redesign valve circuits for transistors, and so obtain the many advantages which the use of transistors can confer. However, owing to the extremely temperature-sensitive nature of semi-conductors, the application of transistors to the field of d.c. amplification is beset with difficulties. The three main parameters which are affected by temperature are the leakage current, the emitter-to-base voltage, and the emitter-to-collector bottoming voltage.

Various leakage currents may be measured in a transistor, depending upon how the electrodes are connected together, but it can be shown that all are related to the reverse leakage current i_{c0} of the collector junction by approximately constant factors. The dependence upon temperature in the normal working range is such that (for germanium junction transistors) i_{c0} is doubled for a rise in junction temperature of about 8° C.



1 *Balanced input stage with stabilizing feedback*

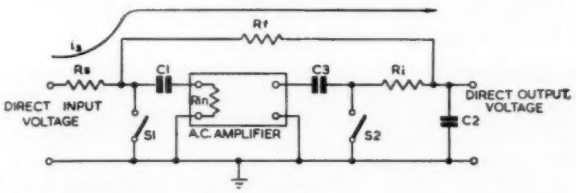
Thus a typical value of i_{c0} of 3 μA at 20° C for a low-frequency transistor becomes 50 μA at 50° C. The temperature-dependence of the leakage currents also affects the emitter-to-base voltage of a transistor amplifier. For germanium transistors this voltage decreases at the rate of about 2·4 mV/° C as the temperature is raised. The limitations set upon the use of transistors in directly-coupled amplifiers are thus quite serious, an input drift of 70 mV and 50 μA being predicted from the above figures for a simple amplifier working in the range 20–50° C.

To overcome the effects of temperature, balancing techniques may be used, the object being to balance temperature-induced variations in one transistor with what are hoped to be equal variations in another similar unit. Such a circuit is shown in Fig. 1. Considerable advantage may be gained in this way at the expense of tedious adjustments, the input drift being reduced to the order of 1 mV and 1 μA for the temperature range quoted.

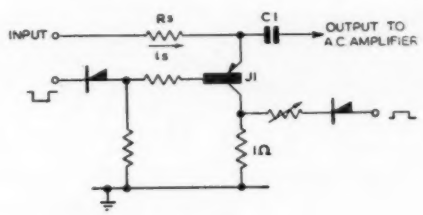
It is difficult to obtain much further improvement in drift with direct-coupled amplifiers and the same transistors, but modulated (chopper-type) amplifier techniques can be used to attain lower drift figures. A well-known system is shown in Fig. 2. The modulation or chopping of the direct input current is carried out by the switch S_1, which periodically diverts the current from the input terminal of the a.c. amplifier. The input signal is thus a rectangular pulse whose amplitude varies with the direct input current. This signal after amplification is demodulated by a second switch S_2 operating in synchronism with S_1, and the resulting output is smoothed by an integrating circuit R_fC_2. If the output signal is of opposite sign to that of the input, negative feedback may be applied by means of resistor R_f in the usual manner.

Transistors have good switching properties and may be used to perform the functions S_1 and S_2. A transistor used in a clamping circuit shows a high collector impedance of the order of 1 megohm when it is cut off, and a low collector impedance of about 10 ohms in the bottomed condition. The drawbacks of such a transistor used as a modulator are that a leakage current flows into the signal source in the cut-off condition, and an emitter-to-collector voltage drop of about 20 mV in the bottomed condition appears in series with the switch when clamped. Both these quantities are temperature dependent and result in drift.

By reversing the emitter and collector connections, an improvement of about 20 times may be obtained in both the magnitude and drift of the leakage current and bottoming voltage, the drifts now being about 10 μA and 100 μV respectively. Unfortunately the current drift is still relatively large and is more serious than the voltage drift for source resistances greater than a few tens of ohms. However, it is possible to eliminate this current drift and replace it by an effective current drift several orders of magnitude smaller. A typical input chopper circuit designed to accomplish this is shown in Fig. 3. In this circuit provision is made for backing-off



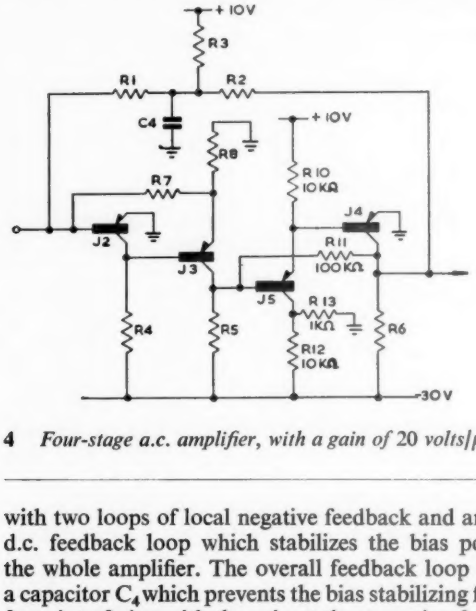
2 *Schematic of chopper amplifier*



3 *Input chopper circuit*

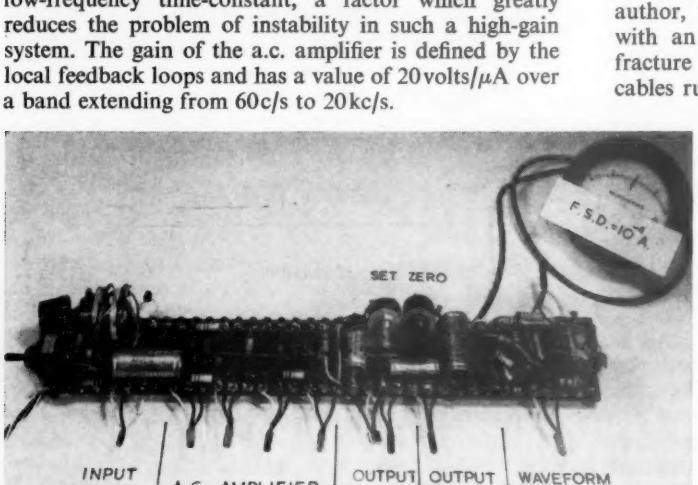
the standing error appearing at the emitter when the transistor is bottomed and the base circuit is designed to prevent the flow of leakage currents when the transistor is in the open-circuit condition.

The a.c. amplifier may consist of a chain of conventional a.c.-coupled transistors. An interesting alternative, shown in Fig. 4, consists of a direct-coupled amplifier



4 *Four-stage a.c. amplifier, with a gain of* 20 *volts/μA*

with two loops of local negative feedback and an overall d.c. feedback loop which stabilizes the bias points for the whole amplifier. The overall feedback loop contains a capacitor C_4 which prevents the bias stabilizing feedback from interfering with the gain at the operating frequency. Since the capacitors at the input and output terminals are essential components of the input and output chopper circuits, the a.c. amplifier itself contains only one capacitor, and thus the response is dependent upon only one low-frequency time-constant, a factor which greatly reduces the problem of instability in such a high-gain system. The gain of the a.c. amplifier is defined by the local feedback loops and has a value of 20 volts/μA over a band extending from 60 c/s to 20 kc/s.



5 *Experimental model of d.c. amplifier*

A complete d.c. amplifier system incorporating the choppers and a.c. amplifier described above has a chopping frequency of 1·6 kc/s, an open-loop gain of 50 volts/μA with a bandwidth extending from zero (d.c.) to 25 c/s. Current drifts of about 4×10^{-9} amp in the range 20–50° C or $2{\cdot}8 \times 10^{-9}$ amp in the range 20–35° C are obtained with this amplifier, with a surface-barrier transistor as the input chopper, whilst in bench operation at room temperature the drift is a decade less.

Fig. 5 shows an experimental model of the complete d.c. amplifier, consisting of an input chopper, a four-transistor amplifier, a two-transistor output stage, an output chopper, and a two-transistor generator for supplying the operating waveforms for the choppers. Such an amplifier has the advantages of being very insensitive to external interference in the form of pick-up, and is also non-microphonic.

These inherent properties of transistors are especially valuable when a 50 c/s carrier must be used. An example of such a system consists of a 50 c/s mechanical chopper combined with a high-gain transistor a.c. amplifier. The sensitivity is such that a 10 μV input signal from a thermocouple is sufficient to close a relay at the output terminals. 621.375.4.024

SYNOPSIS OF A PAPER

Open Installation of Cables

A synopsis of a Utilization Section paper (No. 2484) entitled 'The Case for Open Installation of Metal-Sheathed Cables, with Some Notes on Construction', by W. Holttum, M.Eng., Member. The paper is published this month in Part A of the Proceedings. The author is retired from British Insulated Callender's Cables.

THE PAPER IS AN EXTENSION OF AN EARLIER PAPER BY THE author, which gave details of the incidence, together with an explanation, of the large amount of sheath fracture experienced with lead and lead-alloy-sheathed cables run on hooks. The conclusion was reached that, with correct design, satisfactory life can be obtained for cables so installed.

As a result of that work the author has been led to the further conclusion, briefly recorded in the discussion on the earlier paper, that, contrary to the common view, installation on spaced supports is preferable to any other method where this alternative is available.

The reasons for this conclusion are discussed, and the consideration of construction on spaced supports is extended both as to method and analysis of behaviour. A new method, employing pairs of supports instead of single ones, is described.

The principles and conclusions are applicable to lead- or aluminium-sheathed cables of solid, oil-filled, or gas-pressure type, and to communication cables. 621.315.2

OBITUARY

Obituary notices of only Honorary Members, Members and Companions are published in the Journal.

ROBERT ALEXANDER STEWART BOYTON

Robert Alexander Stewart Boyton, O.B.E., who was born on the 15th June 1885, died on the 16th August 1957, at Convoy, Co. Donegal. He was educated at Trinity College, Glenalmond, and his time there was followed by a four-year electrical engineering course at Faraday House, with practical training with Plenty and Sons, Newbury, and with Staleybridge Hyde.

In 1908 Mr. Boyton joined the British Westinghouse Co. as a member of the distribution erection staff in connection with work for the London County Council tramways. A year later he was appointed Inspection Engineer with the Mexican Light and Power Co., Mexico City, and in 1912 he went to Canada as an erection engineer on the staff of the Canadian Westinghouse Co., Hamilton, where he was in charge of the erection and maintenance of installations for the Western Provinces.

In 1915 he returned to Great Britain to join the staff of the Royal Arsenal, Woolwich, as Assistant Inspector of Fuse Production. But he returned to Canada the next year to be employed as Chief Inspector, Imperial Munitions Board, Ottawa, on examination of fuses and ammunition for the Dominion. For this work he was appointed an O.B.E. in 1918. After a period in 1918–19 as Chief Inspector, Canadian Willis Overland Co., he worked as a consulting engineer from 1919 to 1932. In 1932 he was appointed Manager and Engineer of the Antrim Electricity Supply and Distribution Companies in Northern Ireland. Mr. Boyton retired from active duties in 1947 on the acquisition of the companies by the Electricity Board for Northern Ireland.

During his retirement, he interested himself in the daily affairs of running the estate, one of the largest in Co. Donegal, which he had inherited from his elder brother, and in his well-equipped workshop. He found further leisure for the enjoyment of country life and pursuits, and in nature study and photography, in which he had always taken a keen interest. He took an active part in local church affairs, and in particular the Boy Scouts. He was a man of genial and generous nature with a very wide circle of friends, not only in the electricity supply industry, but among the many members of the community with whom he was in touch over the years in his professional and social activities.

Mr. Boyton joined The Institution as an Associate Member in 1916 and was elected a Member in 1935. He served on the Northern Ireland Section Committee 1936–37. T. G. C.

LESLIE HENRY DANIEL

Leslie Henry Daniel, M.SC.(ENG.), who was born on the 26th April 1906, died at Burton-upon-Trent on the 14th September 1957.

His untimely death brings to an end a wide and varied career. He attended Woolwich Polytechnic Secondary School from 1916 to 1924 and started his technical education at Queen Mary College, where he graduated in 1927. He spent a further year there on post-graduate research, and obtained an M.Sc.(Eng.) degree. He then joined the British Thomson-Houston Co., Rugby, to take a student apprenticeship; at the end of it in 1931 he was appointed to a position in the Electrical Research Association, in which he became an expert on radio interference suppression.

In 1939 he was seconded to the Admiralty; he worked in the shore establishment, H.M.S. *Vernon*, where he was engaged in countering the magnetic mine. He developed a special magneto-meter for obtaining the magnetic characteristics of individual ships. The application of degaussing equipment followed. Later, when transferred on loan to the Ministry of Supply, he was responsible for developing electrical methods of detecting deeply buried mines.

In 1942 he began a long association with fighting vehicles. Part of his early work was concerned with the problem of radio interference suppression, not only the development of satisfactory methods of suppression, but also methods of measurement and the determination of acceptable levels of interference. Later, in 1946, he became a permanent member of the Ministry of Supply, holding the post of Assistant Chief Engineer (Electrical) at the Fighting Vehicles Research and Development Establishment, and was responsible for all electrical development. Promotion to Deputy Chief Engineer followed, in which capacity he had general responsibility for the design and development of all tracked armoured vehicles. His main work was the conception of the Conqueror, Britain's biggest tank, and his policy and his drive in the painstaking development and improvement of the Centurion have resulted in its very high efficiency and reliability, which are reflected in the remarkable export trade in these vehicles.

Mr. Daniel was appointed Director of a new branch of the National Coal Board in March 1954—the Central Engineering Establishment, formed to develop and test new methods and equipment for coal production. Starting with a bare field at Bretby in Derbyshire, he threw all his energies into the design, construction and equipping of the establishment, which now stands as a monument to his labours. As the buildings took shape, he gathered around him a personally selected team of engineers, which he inspired with a remarkable driving force; anyone who came into contact with him could not fail to feel the effect.

He was a man of considerable foresight and administrative ability and a great believer in personal contact. A seemingly jocular exterior covered a deep interest in human nature. Many have profited from his advice and reasoning. He was a keen gardener, although his work at Bretby left him with little time for this hobby. Although never an active participant, he enjoyed the cut and thrust of politics, being a master of repartee.

He was a member of a very united family. He leaves a widow and two sons, both of whom are now serving apprenticeships with engineering firms.

He joined The Institution as a Student in 1925 and was elected a Graduate in 1929, an Associate Member in 1934 and a Member in 1946. He served on the Measurements Section Committee 1947–50 and the Informal Meetings Committee 1948–50. He wrote a joint paper with Dr. G. Mole, entitled 'The Measurement of Interference at Ultra-High Frequencies', which was published in the *Journal* in 1941. H. L. T.

ANDREW HOWARD GORDON

Andrew Howard Gordon was an Aberdonian, born on the 18th October 1881, the son of a banker who became Manager of the Union Bank of Scotland, Cornhill. He was educated at University College School and at a Moravian school in Germany. On leaving school in 1897 he began his engineering education by taking a year's mechanical course at the City and Guilds Technical College, Finsbury. He then served a three-year apprenticeship with the New Southgate Engineering Co., and in 1901 attended the Finsbury Technical College again to take a two-year electrical engineering course under Silvanus P. Thompson. This was followed by two years' practical training with the British Westinghouse Co.

In 1905 he joined Mather and Platt Ltd., Manchester, and in 1909 was transferred to London. Here he became a keen member of the London Scottish Volunteers. While in Manchester he married Agnes Stewart Coubrough, the daughter of Antony Sykes Coubrough of Blanefield.

In 1913 he went to Buenos Aires to take up an appointment as Manager and Chief Engineer for Mather and Platt, but in 1915 returned to England, at his own expense, to do war service, first at

Gretna Green and then, with a commission in the Royal Engineers, in Palestine and elsewhere in the Middle East.

With the 1914–18 War over, he founded an agency for British engineering firms in Shanghai and then, in 1923, became Chief Engineer and Manager at Shanghai for Callender's Cable and Construction Co. in China. Stormy times for China lay ahead, and he had stirring adventures during the Civil War in 1926. Next came a great deal of travelling in the interior, often with his wife as his companion. After her death in 1931, his daughter took her mother's place and made many journeys with him in parts of China little known to Europeans.

In 1931, when North and South China were at war, he served in the Scottish unit of the Shanghai Volunteer Corps to protect the boundaries of the settlement from turmoil. Later came more travelling up the rivers, in which he supervised the installation of many submarine-cable river-crossings. In 1936 he became a partner in the firm of Marden and Co., and lived on a houseboat on the Whangpoo, until the Sino-Japanese War forced him to leave the river. About 1941 he ran a camp-farm, largely for indigent Europeans, many of them old Scouts and Rovers (he was a Commissioner of Boy Scouts in Shanghai), bicycling to the office every day, ten miles each way. He was later arrested by the Japanese, along with other prominent Europeans, but was well treated, though of course poorly fed. He was interned at Haiphong from 1942 until 1946, and then transferred to Peking in a wired-in cattle truck on a journey lasting three days and nights.

After peace returned, his business was re-opened and he was most hospitably entertained by his many old Chinese friends, for whom he had great affection. He became Master of his Masonic Lodge, and was awarded the *Silver Wolf* of the Boy Scouts. He was also a Rotarian. In 1949 he went sick and left China for good, retiring to New Zealand to be near his daughter, who was living there. Some years later he returned to England, and afterwards died in Malta.

All his life he was a most gregarious man, with a real appreciation of his fellow-mortals, of whatever race or creed. He loved China wholeheartedly and gave her of his best. He was full of life and energy. To see Howard Gordon dancing, with his head thrown well back and enjoying every minute of it, was a thing never to be forgotten, and many regret the passing of this tall handsome Scot, with his wavy hair and his bright challenging eye.

Mr. Gordon joined The Institution as a Student in 1902 and was elected an Associate Member in 1907 and a Member in 1934.

W. G. H.

JOHN SEDGWICK PECK

John Sedgwick Peck, M.E., a former Director and Chief Electrical Engineer of the Metropolitan-Vickers Electrical Co., who died on the 17th October 1957, was born in New Haven, Connecticut, on the 30th November 1871. He graduated from Cornell University in 1892 with the degree of M.E. and, after a short period with the Eddy Electrical Manufacturing Co., entered a student apprenticeship with the Westinghouse Electric and Manufacturing Co., Pittsburg, in 1893, with a salary of $1 per day.

In 1895 the works of the company were moved to East Pittsburg, with the late Mr. P. A. Lange as General Works Manager, and Peck became Chief Engineer, Transformer Department, taking charge also of lightning arrester development. He transferred to the British Westinghouse Co. in 1904, and when Lange joined the company as General Manager of Works in 1906, he took Peck onto his personal staff as Consulting Electrical Engineer. In 1915 Peck succeeded Rosenberg as Chief Electrical Engineer, and in 1928 he became a Director of the company, by then known as the Metropolitan-Vickers Electrical Co. He retired in June 1941 after more than thirty-six years' service.

Since entering the electrical engineering profession as a young man, Peck had played a leading part in the development of the industry. Besides having responsibility for all advances in electrical design made by his company, he rendered valuable service in the selection of staff; a sound judgment enabled him to assemble a team who soon became recognized as experts in their own line. Always a consistent supporter of national and international standardization in engineering, he was generous in allowing his engineers to serve on B.S.I. and I.E.C. committees, and he was himself a member of the main Electrical Industry Committee of the B.S.I. for some years.

During his long career Peck took a deep interest in the social life of the works, and few can have done more to encourage the spirit of good comradeship and mutual help. He was a founder member of the Metropolitan-Vickers Lawn Tennis Club (being himself a keen player and presenting a cup which is still competed for), and the opening of a new bowling green at the British Westinghouse Club in 1912 was celebrated with a match between Peck and Lange. Always a keen golfer, he continued to play regularly to within a few months of his death. The regard and affection in which he was held by his many associates is best typified by the title 'Father Peck', by which he became known.

Mr. Peck joined The Institution as an Associate Member in 1903 and was elected a Member in 1907. He served on the Manchester Local Section Committee for a number of years, being Chairman 1910–11, on the Manchester Students' Committee, and on the North-Western Centre Committee. He wrote several papers which were published in the *Journal* of The Institution, including 'Protective Devices for High-Tension Transmission Circuits'; 'Flywheel Load Equalizers', for which he was awarded a premium; 'Earthed Versus Unearthed Neutrals on Alternating-Current Systems', for which he was awarded the Paris Premium; and 'The Parallel Operation of Electric Power Stations'.

C. D.

WILLIAM PHILLIPS

William Phillips, who died on the 10th October 1957 at his home in Blackheath, was born at Berkhamsted in 1877. He was educated at Berkhamsted School and received his technical training at the City and Guilds Central Technical College. Here he obtained a diploma and also a silver medal for electric light and power, a subject then in its infancy.

After a short period with Verity's Ltd., he joined Elliott Brothers in September 1896 and he was still in active service with the firm at the time of his death. He thus completed 61 years of continuous service. Mr. Phillips was for many years Chief Engineer to the company, and in that capacity he also took control of the company's first research laboratory, which was opened in 1928. In his latter years he acted in an advisory capacity on electrical measurements, patents and instrument bibliography.

At various times Mr. Phillips served on many electrical engineering committees, namely those of the British Standards Institution, the Electrical Research Association and the British Electrical and Allied Manufacturers' Association, and he was chairman of a number of them. He was made an Honorary Member of the B.S.I. for his services.

He was responsible for many of the early designs of electrical measuring instruments, a number of which, except for minor modifications, are in production to this day. Mr. Phillips's enthusiasm for the development of new ideas was unlimited. An outstanding engineer, particularly in the electrical instrument field, he devoted many years of his life to obtain more reliable and more accurate electrical measuring instruments. He was a pioneer in instrument transformer design, and he introduced the high-permeability nickel-iron core into current transformers to produce the first real precision instruments of this kind.

Mr. Phillips was an inspiration to all those who worked with him, and he had a keen sense of humour, as was often illustrated by many of his tales of his early engineering experiences. In between his many activities, 'W.P.', as he was affectionately known to his colleagues, found some time for his favourite diversions, rose growing, lawn tennis and golf. He became a founder member of the Elliott Long Service Association in 1928 and was President of the Association from 1945 onwards.

Mr. Phillips joined The Institution as an Associate in 1898 and was elected an Associate Member in 1905 and a Member in 1914. He was Chairman of the Meter and Instrument Section 1941–42 and wrote a Progress Review on 'Electrical Measuring Instruments', which was published in the *Journal*.

H. D.

TECHNICAL PUBLICATIONS

BRITISH STANDARDS

Copies of the following publications can be obtained from the British Standards Institution, 2 Park Street, London, W.1. The prices given are post free.

B.S. 7: 1953 **Rubber-Insulated Cables and Flexible Cords for Electric Power and Lighting** Amendment No. 3 (P.D. 2935) 1s.

The two principal purposes of this amendment are to substitute references to B.S. 2899 for the existing requirements for rubber insulation and sheath and to provide for the manufacture of the smaller sizes of braided and compounded cables without a layer of proofed tape over the insulation.

The change in rubber content of general-purpose insulation, introduced in B.S. 2899, has made it necessary to revise the values of minimum insulation resistance specified for cables made with this kind of insulation. The new values are generally about 25% of those formerly required. Revised tables of dimensions are given for those types of cable affected by the omission of proofed tape from the smaller sizes, and the opportunity has been taken to specify some of these dimensions to a greater degree of accuracy than formerly, to obviate difficulties in inspection.

The amendment makes a number of other changes in the Standard which affect house-service overhead system cables, tough-rubber-sheathed flexible cords and unkinkable flexible cords.

A number of other amendments necessitated by the changes in B.S. 7 have also been published.

B.S. 883: 1958 **Cables and Flexible Cords for Electrical Equipment of Ships** 15s.

This revision aligns the Standard with B.S. 7: 1953, B.S. 480: 1954 and B.S. 608: 1956 for rubber-insulated, paper-insulated and varnished-cambric-insulated cables respectively, as far as the special conditions of shipboard use permit. One additional type of cable, polychloroprene-sheathed without braid, has been introduced. Tough rubber-sheathed cables, apart from flexible cables and flexible cords, are no longer specified for use in ships; they have been superseded for this purpose by the more fire-resistant polychloroprene-sheathed cables.

The quality of rubber insulation, rubber-like fire-resisting insulation, rubber sheath and polychloroprene sheath is defined by reference to B.S. 2899. The requirements for paper insulation and varnish-cambric-insulation are similar to those of B.S. 480 and B.S. 608, respectively. The section on mineral-insulated cables has been omitted from this edition of B.S. 883, because a new British Standard for mineral-insulated cables, which will be equally applicable to cables for use on land and in ships, is expected to be published shortly.

B.S. 1645: 1957 **Domestic Electric Vacuum Cleaners** 6s.

A British Standard for domestic vacuum cleaners was first published in 1951 as part of a series to promote safety of domestic appliances by specifying appropriate tests and design and constructional details. A new series of tests on the finished product is specified in this revision of the Standard.

Typical is the test for 'impact strength', which requires that every potentially weak point of the cleaner should be subjected to three blows by a striking element with an impact energy of 4·4 in-lb. per blow. Typical points to be tested are handles, knobs, levers, and so on. The test must leave the cleaner undamaged within the specified meaning of that term. Many other type tests are provided for.

With a view to assisting manufacturers to design vacuum cleaners suitable for both home and export markets, steps have been taken to bring the Standard more closely into line with the relevant specification for motor-driven appliances issued by the International Commission on Rules for the Approval of Electrical Equipment (C.E.E.). Hence the inclusion of the C.E.E. tests for 'impact strength' and 'resistance to tracking'.

Manufacturers who make their products conform with this Standard are required to indicate the fact by including the number B.S. 1645 on the name plate, or they may apply for a licence to use the 'Kite' mark, as one prominent firm has already done.

B.S. 2914: 1957 **Surge Diverters for Alternating-Current High-Voltage Power Circuits** 8s. 6d.

The surge diverters (lightning arresters) specified in this new Standard are primarily for protecting high-voltage equipment installed in power stations or substations connected by overhead lines. More specifically, the diverters are of the type which contain a single or multiple spark-gap in series with one or more non-linear resistors for use on alternating-current power circuits at system voltages of 1·1 kV and upwards.

Lightning arresters are being made the subject of an international recommendation by the International Electrotechnical Commission; and the work of the relevant I.E.C. committee has been taken into account.

Two of the three principal sections of the Standard are devoted to testing, which is of three kinds:

(i) *Type tests* for demonstrating compliance of a given design of diverter with the standard.

(ii) *Sample tests* made at the purchaser's request on a proportion of the diverters in an order.

(iii) *Routine tests* made by the manufacturer on all diverters.

B.S. 2917: 1957 **Graphical Symbols for Use in Diagrams for Fluid Power Transmission and Control Systems** 8s. 6d.

The symbols in this new forty-page Standard are for use in the general field of engineering, excluding aircraft engineering. Specifically, they are basic symbols for transmission and power control systems employing a hydraulic liquid or gas. They are shown in conjunction with rules for their use.

The Standard is similar to the Joint Industry Conference Code in use in the United States; and it is in accord with the American Standards Association Code which has been drafted.

In Section One many symbols are illustrated and concisely annotated, and simplified symbols are shown for complicated arrangements. Section Two is devoted to composite symbols. Section Three includes nine complete diagrams for machines and equipments. The diagrams illustrate the use of the

symbols for very detailed cases, and will prove of considerable assistance to draughtsmen and illustrators.

Taken as a whole, the three sections of the standard show the development of basic symbols into complicated general equipment arrangements as well as showing the method of indicating actuation.

B.S. 2918: 1957 Determination of Electric Strength of Solid Insulating Materials at Power Frequencies for Industrial Purposes 6s.

The tests described in this Standard are intended to be used for purposes of investigation and design, and also as control and routine tests in specifications.

The appendices contain recommendations on the selection of test procedures, on the most suitable form of testing equipment, and on matters which should be included in any description of an electric-strength test.

B.S. E.24: 1957 Nyvin Type Electric Cables for Aircraft 7s. 6d.

This new Standard specifies requirements for cables having an insulation of p.v.c. compound and glass braid with a protective covering of nylon. Provision is also made for a range of cables with an outer covering of metal braid.

The cables are suitable for use in aircraft circuits in which the voltage between conductors, between the conductor and metal braid surrounding it and between a conductor and the aircraft structure does not exceed 600 volts (r.m.s.) and in which the frequency does not exceed 1 600 c/s. They are suitable for use where, in continuous service, no combination of ambient temperature and conductor current produces a stabilized conductor temperature in excess of 90° C.

The cables are suitable for fixed wiring in aircraft at temperatures down to −75° C, but are not suitable for severe flexing at temperatures below −30° C. They do not support combustion, and they are suitable for use in areas where ester-based fluids are present.

The Standard specifies the requirements for materials used in the construction of the cables; other requirements deal with dimensions, identification, packing and labelling. Details are also given of type tests, production routine and production quality tests.

B.B.C.

B.B.C. Handbook 1958 5s.

This annually published book gives a full account of the constitution, administration and finances of the B.B.C., of its home and oversea services, its programme policy and its relations with the public and with other countries. The Engineering Division now has a staff numbering over 5 000, of whom over 3 000 are technical personnel. The B.B.C. operates fifty-three sound transmitting stations and seventeen television stations, and in addition there are thirty-nine high-power transmitters for oversea broadcasts. The book describes the latest techniques used by the B.B.C. for making studio and outside broadcasts and for the recording of sound. It also outlines the type of work at present being carried out in the Specialist Departments—research, design, installation and building.

A review of broadcasting over the past year reveals that the interference with medium-wave broadcasts by foreign stations increased considerably during 1957, and the only solution has been to further the development of v.h.f. broadcasting. More v.h.f. stations were brought into service, and by the end of 1958 some 96% of the population will be covered. Interference with B.B.C. television reception was also experienced owing to increased solar activity, which may be expected to decline in the course of the next few years. The effective radiated power of the Crystal Palace transmitter has been doubled to 200 kW, and the coverage of B.B.C. television exceeded 98% of the population by the end of 1957. Work on colour television continued, and a further series of test transmissions began in October 1957, using the N.T.S.C. system adapted to suit the 405-line standard.

A considerable amount of reference information, including tables, maps and charts, is included at the end of the book.

NATIONAL COAL BOARD

Information Bulletin No. 57/188 **Electrical Accidents at Collieries** (with special reference to the Effects of Electric Shock)

This interesting and very readable report describes the effects of electricity on the human body. Although its title relates especially to collieries, it is applicable to a much wider range of industry; it is indeed of a general nature. The first section outlines the medical aspects of electricity; namely, the effects of flash, including burning; electrical necrosis (death of tissues subjected to heavy current); and electric shock (the effect on the heart and brain).

This section is followed by an electrotechnical analysis of many accidents, both fatal and non-fatal, giving values of electric current for the thresholds of perception, of muscular decontrol, of danger to life, and of fibrillation. A concise account is given of various researches carried out to ascertain the electrical resistance of the body. The results show a variation of 100–10 000 ohms for conduction between the hands, but Freiberger has demonstrated the importance of the epidermis (outer layer of skin), which offers greatest resistance to electricity. When contacts were made below the epidermis the resistance between hand and feet was constant at 600 ohms at all voltages. The epidermis raises this value to about 100 000 ohms, but is strongly voltage dependent and varies with the toughness of the skin. Breakdown of the epidermis of the finger begins at 20 volts a.c. and is virtually complete at 400 volts. Resistance to direct current is 20–40% greater.

The analysis of the data relating to electrical accidents at collieries proved to be difficult, owing to the diversity of the figures. One case was recorded of a young man dying from a half-minute contact with 56 volts a.c. between the hands under dry conditions, while another case showed that a 3-second exposure to 3 300 volts a.c. between hand and feet under damp conditions failed to render a 45-year-old man unconscious. These are extreme cases and may be due to inaccurate data. The report derives average values of voltage, duration of contact, shock current, electric charge and total electrical energy passed, for both fatal and non-fatal accidents. The ratio of these values, fatal to non-fatal, were:

Duration	2·17 : 1	Charge passed	3·4 : 1
Shock current	2·5 : 1	Energy passed	10 : 1

In conclusion there are a few paragraphs on the treatment of electrical injuries, which stress the need for immediate artificial respiration for an unconscious patient, and the use of oxygen as soon as possible.

The report may be obtained free of charge from the National Coal Board, Hobart House, Grosvenor Place, London, S.W.1.

SOME RECENT BOOKS

E. G. CULLWICK

ELECTROMAGNETISM AND RELATIVITY

LONGMANS, GREEN. 1957. 299 PP. £3 3S.

This is an important and timely book. Few electrical engineers would admit to being ignorant about electromagnetism, which is the foundation-stone of all their work. But most of us would hesitate even to discuss relativity theory except with our close friends. A reason for the reluctance of electrical engineers to grapple with relativity theory is found in a footnote in Professor Cullwick's preface. He quotes Sir James Jeans as saying: 'The signal for the revolution was a short paper which Einstein published in June 1905. And with this publication the study of the inner workings of nature passed from the engineer-scientist to the mathematician . . . no one except a mathematician need ever hope fully to understand . . . the theory of relativity.' Professor Cullwick comments, 'It seems scarcely necessary to add that Jeans was a mathematician'.

Professor Cullwick is a brave man. He evidently believes that relativity theory can be understood by those whose thinking is not done entirely in mathematical symbols. Moreover he doubts that mathematical treatment is sufficient by itself. He sees the danger of the mathematical method to lie in 'the ease with which errors in physical interpretation can be obscured by mathematical elegance'. He, therefore, sets himself the task to give a physical interpretation to the equations used in his book. Anybody who has tried such a thing will know the immense difficulties in the way. Let the reader who doubts this try to explain the physical meaning of inductance to his wife. Professor Cullwick has not been entirely successful. His book still bristles with unexplained mathematics (see, e.g., Chapter VII). But he has succeeded here and there. Some of the mathematical undergrowth has been removed. Let others sharpen their wits and clear the path further.

The book opens with the discussion of some simple cases of electromagnetic systems in uniform rectilinear motion. There is a very clear discussion of the various field components, and excellent use is made of an important but neglected theorem due to Poisson about equivalent charge and pole distributions. There follows an introduction to the special theory of relativity and a discussion of the Lorentz transformation applied to Maxwell's equations. Electromagnetic induction is the next subject discussed. There is a very useful section on electromotive force and potential difference, which deserves the attention of all teachers—whether of O level schoolboys or research graduates. Professor Cullwick then discusses the motional and transformer effects, known to many as the 'cutting' and 'threading' rules, and he is not afraid to give a definite answer to the old problem of e.m.f. induced in a rotating cylindrical magnet. Energy and momentum in the electric field occupy his attention in the last part of the book. He outlines his fascinating theory of electron inertia and shows how superconducting effects can be explained.

To the practising engineer the most important question raised and answered by this book may well be: 'What results, if any, can be obtained by relativity theory that cannot be obtained by Maxwell's equations?' Professor Cullwick divides his answer into two parts. He considers first-order effects in which the velocity v of the charges and magnets is small compared with the velocity of light c, so that v^2/c^2 can be neglected. Then he considers second-order effects where v^2/c^2 must be taken into account.

First-order effects are found not to require relativity theory, if the treatment is based on the twin concepts of electric charge and magnetic pole. If, however, the concept of magnetic polarity is abandoned, special relativity is essential to give correct answers. This is a most important conclusion and should be pondered by those who have an aversion to magnetism. Is it really desirable to teach the Lorentz transformation rather than magnetism at school or in National Certificate courses? The second-order effects can also be correctly predicted by Maxwell's theory alone, but special relativity may well be desirable because of its simplicity and convenience in writing the equations.

Readers of this book should not be surprised or annoyed if they disagree with the author at times. The reviewer remains wholly unconvinced by the discussion of the e.m.f. in a rotating magnet. Indeed, this is not a book for those who feel that electromagnetism is a closed subject. Professor Cullwick everywhere breaks through accepted doctrine and stimulates his readers to fresh thought. We are greatly in his debt.

W. E. BENHAM and **I. A. HARRIS**

THE ULTRA HIGH FREQUENCY PERFORMANCE OF RECEIVING VALVES

MACDONALD. 1957. 178 PP. 28S.

A book of this kind, integrating the work of various writers over the past twenty years, is needed, and the authors, both well known for their contributions to the subject, have made full use of their theoretical experience. To the academic student the volume will be of value, for it gives, as no previous book has given, a unified description of the actions in space-charge-modulated valves which have produced a plethora of attempted explanations since the first appearance of *Mehrgitterelektronenröhren*. The only doubt the reviewer has of the usefulness of the text is that it deals throughout with ideal cases—complex enough in many cases, but nevertheless ideal so far as the engineer or designer is concerned. Briefly, although the authors have done well to bring into logical form 'the work of Muller, Llewellyn, Bakker, de Vries, North and Benham', they are still faced with the unalterable fact that all of this work presupposes an electron charge configuration which is not representative of a valve used at u.h.f. in the space-charge-modulated condition. This must be the complaint of the valve engineer.

It is slightly surprising to see $\mathscr{E}$ used for electric field strength, since this symbol was officially abandoned by the British Standards Institution several years ago. Another point of presentation is that the printing of the superscript characters in exponential functions is often badly executed. [See e.g. p. 36, equation (3.16); p. 46, equation (3.51); p. 98, the line above equation (7.13), in which the superscript characters appear to be part of the main algebraic expression; and

p. 116, two lines from the bottom, where 'tau' is printed as 't'.] A little extra care by the printer's reader and editor can go a long way in establishing one's confidence in mathematical formulae given in a book of this type.

There are some curious statements in the early part of the book. On p. 13 the authors state that they will neglect the interaction between the grid-cathode and grid-anode spaces of a triode, since the fraction of the field of space I that penetrates into space II is substantially $1/\mu$, and that the fraction of the space II field penetrating space I is substantially (d_2/d_1) $(1/\mu)$, where d_2 is the grid-anode and d_1 the grid-cathode spacing. They feel that since μ is usually greater than 20 these fractions may be neglected. Fortunately, in the remainder of the book they do not stick to this conclusion, and the reader gets better value than he expected.

As already implied, the valve engineer must give the differences between actual and ideal valves considered in Chapter 5 much greater weight than the authors do; but this does not seriously detract from the value of the text to the advanced student, who is provided with an excellent platform from which to launch himself into the unsolved problems of this exciting domain.

W. C. MICHELS

ELECTRICAL MEASUREMENTS AND THEIR APPLICATIONS

NEW JERSEY: VAN NOSTRAND. LONDON: MACMILLAN. 1957. 331 PP. £2 11S.

This book is based upon an earlier work by the same author entitled 'Advanced Electrical Measurements', which was first published in 1931, but it has been rewritten in order to cover recent advances in measurements.

The book is divided into two parts, the first dealing with basic measuring techniques and the second with applications. All chapters in the first part include details of laboratory experiments that may be carried out to illustrate the theoretical work.

The first chapter deals with the correct manner of carrying out an experiment and includes an excellent treatment of error calculation. Chapters 2 and 3 cover direct-current measurements by deflection instruments and null methods respectively, and are followed by two chapters dealing with low-frequency deflection instruments and a.c. bridges. The treatment of a.c. bridges is rather curtailed, considering their importance in measurements, and no reference is made to inductively coupled ratios, which are now common. There are some diagrammatic errors in this chapter.

The basic principles of amplifier design are discussed in Chapter 6, and a useful discussion on transient analysis based on the Fourier Integral theorem is included. Chapter 7 on oscillographs deals with the theory and applications of the cathode-ray oscilloscope, and the electromagnetic oscillograph. Simple measurements at radio frequencies are dealt with in Chapter 8, and the final chapter in Part I covers higher-frequency measurements involving the use of loss-free transmission lines and waveguides.

Part II of the book contains chapters on magnetic measurements, electrical thermometry, electrical measurements in mechanics and acoustics, and electrical measurements in nuclear physics. These chapters are the most attractive feature of this book, and a wealth of essential information is given in them. Nuclear resonance techniques are introduced in the chapter on magnetic measurements. The chapter on thermometry deals with resistance thermometers, thermocouples, optical and radiation pyrometers and includes all essential theory. The following chapter describes electromechanical transducers, then deals with acoustic measurements and concludes with a section on vacuum pressure measurement.

The final chapter on nuclear physics is a useful introduction to an important field of measurement. The various types of counter and associated electronic apparatus are described, and the application of statistical method to counting problems is discussed.

This is an excellent book, well written, clear and concise throughout, and provided with a good bibliography. It is particularly suitable for advanced electrical engineering students in their two final years, but any engineer who has to deal with problems in any field of electrical measurements will find it to be of considerable value.

PIEZOELECTRICITY

H.M. STATIONERY OFFICE. 1957. 369 PP. £3 15S.

This selection of Post Office Research Station reports is essentially for the specialist; the electrical engineer wishing to obtain a general grasp of the subject must satisfy his needs elsewhere. One is immediately conscious that no practicable amount of editing of reports prepared originally for private circulation can yield a fully satisfactory book, but this statement should not discourage a worth-while experiment in the dissemination of the research results of one of our major national laboratories. It is an example that might well be copied, and improved upon with experience.

There has, of course, been no attempt to produce a comprehensive treatise such as W. G. Cady's book of the same title, but the reports have been arranged in logical order: theoretical treatment; measuring equipment and techniques; and descriptions of piezo-electric crystals, including how they are grown and cut and their experimentally determined properties. Apart from the theoretical treatment, which is quite general, the subject-matter is effectively confined to those crystals which are water-soluble under normal pressure conditions; quartz, which has to be grown hydrothermally, and ferro-electric materials are excluded. These omissions have been made deliberately, but one regrets that the editorial staff did not add a short introductory chapter to give the background of the work. In default of this, the reviewer can refer only to the acute war-time shortage of natural Brazilian quartz for the control and selection of frequency in telecommunication, and the need for a laboratory-grown piezo-electric material as a precaution against a recurrence of this scarcity. Consistent with their interests, the Post Office turned the main attention of their staff to water-soluble crystals, which offered prospects of easy growth and adequate frequency stability for multi-channel carrier telephony.

Much of the work described, although excellent of its kind, is no longer topical. One of the main results achieved was confirmation of the value of ethylene-diamine-tartrate resonator plates for use in channel filters, after the initial discovery and groundwork by American workers. In present-day circumstances it now seems highly improbable that this material will ever be used on a commercial scale. Consequently, it is in the possible application of some of the other crystals (such as lithium sulphate and ammonium dihydrogen phosphate) to electro-acoustics that the value of the work must now be sought. In this connection, the set of data tables forms a welcome conclusion to the book and should be of

real value for reference purposes. Also, it is fair to add that the well-presented descriptions of crystal-growing techniques have a contemporary value outside the field of piezo-electricity.

The earlier chapters giving the theory of the tensor properties and the dynamic behaviour of piezo-electric crystals contain little that cannot be found in the existing standard works, but they have the merit of providing a self-contained exposition which should save the time of those who find the notation employed sufficiently readable. It is an unfortunate fact that a wide divergence in piezo-electric terminology still exists, and the present book makes no contribution towards solving this problem. There appears in fact to be a somewhat excessive use of symbols in the first chapters, particularly those having subscript and superscript characters; such characters look clumsy since the book is not printed from type, having apparently been set on a typewriter without provision for smaller characters. Moreover the horizontal letter spacing is uniform as with an ordinary office typewriter, which somewhat reduces the readability of the book. Despite these defects the general presentation is fairly good and the price represents sound value.

R. F. SHEA (*Editor*)

TRANSISTOR CIRCUIT ENGINEERING

JOHN WILEY AND SONS. 1957. 468 PP. £4 16s.

A high standard has been set by Dr. Shea's previous books; for this reason the present work will be received with unusual interest. It is more ambitious than its predecessors, the wide range covered being indicated by the chapter headings: Characteristics and Characteristic Curves; Equivalent Circuits; Bias and Its Stabilization; Audio Amplifiers; D.C. Amplifiers and Their Applications; Tuned Amplifiers; Video Amplifiers; Oscillators; Modulation, Mixing, and Detection; Transient Response and Pulse Circuits; Systems; and Special Circuits. Dr. Shea has wisely not attempted to write the book alone. Eight co-authors are listed on the cover and the contributions of five others are acknowledged. Co-ordinating the work of some fourteen experts cannot be an easy task, and it is not surprising that the book seems at times rather disjointed and that the quality of the material is variable. At its best the book is first-rate, at its worst it is mediocre; but it never descends to the unreliability, inaccuracy and remoteness from reality which have characterized some books on transistor circuits.

The earlier chapters give excellent advice on the circuit design necessary to allow for expected variations in transistor characteristics, but this advice seems often to be forgotten in the circuits presented later. In showing the principles of a circuit, refinements should be omitted; but it is not always easy for the reader of this book to see which circuits are intended to illustrate basic principles and which are to be regarded as examples of good circuit engineering. Many of the circuits shown would require quite knowledgeable treatment to make them reliable and reproducible.

The multiple authorship shows itself in several ways. Sometimes duplication could have been avoided by reference to other chapters; for example the section in Chapter 7 on video power amplifiers could usefully have drawn on the section in Chapter 4 on audio power amplifiers. The polarity conventions used in the circuit diagrams are chaotic; sometimes the positive voltage line is at the top of the diagram, sometimes the negative. In Fig. 5.20 the earth line is at the top, the +20-volt supply line is at the middle of the page and the −10-volt at the bottom. This lack of uniformity appears to have confused the authors themselves: Fig. 8.29 uses *n-p-n* transistors, so that the polarity of the power supply line at the top of the diagram is presumably positive (though this is not marked); however, on p. 253 the operation of this circuit is described as if the transistors were of the *p-n-p* type, and a negative voltage were supplied to the circuit.

There are a few mistakes: e.g. on p. 94 the values of capacitors C1 and C2 have been miscalculated by a factor of 10, and in Fig. 10.3 the expression for the high-frequency current gain of a transistor is given incorrectly. In the chapter on d.c. amplifiers there is a good deal of confusion about amplifier drift and sensitivity (the two terms seem to be used interchangeably).

The description of carrier storage effects in junction diodes is open to question. Figs. 9.1 and 12.11 both show the voltage/current characteristic of the diode passing through the origin when stored minority carriers are present, and indicate that the diode impedance has a maximum at the origin. It can be shown theoretically and experimentally that this is not true. A simplified explanation of the rather complex expressions for carrier storage presented on p. 315 would have been welcome, especially in view of the difficulty of the paper in which they originally appeared.

The index is comprehensive but somewhat capricious. Thus under 'point-contact transistor' we are referred only to p. 19, where this device is dismissed in six lines; yet in Chapter 8 some four pages are devoted to it. Again, for the '*p-n-p-n* transistor' the reader is directed only to Chapter 8, where circuit applications are very briefly described; the index does not show that the operation of this transistor is fairly fully described in Chapter 1.

The bibliography at the end of the book contains more than 350 references, but only a dozen of these are from sources outside the United States and there is practically no reference in the text to British work.

However, despite these and other faults the average standard of the book is high and the information it contains should be valuable, if used with discrimination. It seems likely to achieve what is clearly its objective, namely to become the standard work on transistor circuits.

W. SCHUISKY

INDUKTIONSMACHINEN

SPRINGER-VERLAG. 1957. 501 PP. £7 11s. 6d.

The author of this book is consulting engineer to the ASEA company in Sweden, and is already well known through his book *Electromotoren*, which was published in 1951. In reading his new work, one is left in no doubt as to the author's long and all-embracing experience in his field.

The book is primarily intended for the practising engineer. The matter is presented in such a manner, however, that the advanced student will follow it with comparative ease, and he will have much to gain from a careful study of its 500 pages.

Dr. Schuisky has successfully brought together the latest developments in the field (particularly in respect of starting characteristics, reduction of losses and speed control), his own work, and that of many others, and has co-ordinated this with the classical theory of induction machines. The book is, nevertheless, essentially practical in outlook, and problems of a distinctly academic nature are not discussed, or at the most, but briefly.

The book opens with some notes of historical interest on the early development of the induction motor. The second chapter deals with the mechanical aspects of the construction

of the various types of machine, the means of cooling and the modes of protection required as a result of the machine's situation or specific use, all in relation to German standards. There are many excellent photographs and a great deal of data and specifications in the form of tables.

Chapter 3 deals with the design of stator and rotor windings and their insulation. The data for split-windings for pole-changing motors are most comprehensive. The next four chapters provide a study of magnetic characteristics, effective resistance, leakage reactance and the magnetic field, thus leading to Chapter 8 on the operational characteristics of the polyphase induction motor. Conventional methods of analysis are adopted, and the accompanying circle and vector diagrams and equivalent circuits are excellently presented, the explanations of their origin and use being both concise and clear. The use of symmetrical components is first developed in the study of the air-gap flux in relation to the analysis of the elliptical rotating field. The general effects of harmonics are covered in great detail in Chapter 9, with particular reference to noise and losses.

Chapters on heating under steady and transient conditions, mechanical stresses within the machine, starting of the various types of machine, analysis of unbalanced conditions in stator and rotor, and speed control methods, are followed by a full treatment of the single-phase induction motor and its modifications. There is a discussion and analysis of the many special applications of the induction machine, but the linear induction motor is not mentioned. Other chapters treat of losses, efficiency and the experimental determination of these quantities, together with methods of measurement of stray losses, insulation tests and practical tests of the machine.

The foregoing theory is implemented in the concluding sections of the book to present the full design process. There is a particularly interesting and useful section on the proportionality of load and chief dimensions (inner diameter of stator and armature length) for various series of machines. Finally, there are worked-out design examples for a 200 h.p. double-cage motor, a frequency changer, a small single-phase motor without auxiliary winding and a split-pole motor.

There is an extensive bibliography, but the author points out that it is impossible to include any but the most important references in a field so wide.

MONOGRAPHS AND PAPERS
published individually this month

Synopses of monographs and papers published individually before the next issue of the Journal are given below, and, unless otherwise stated, their dates of publication are this month. Reprints of all papers are available about two months after publication in the Proceedings. The prices shown below are post free. When ordering please quote serial number of paper or monograph. Books of 8 vouchers may be obtained from the Secretary, price 10s. each.

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MONOGRAPHS

Eddy-Current Losses in Thin Ferromagnetic Sheets
Monograph 284 M

E. W. LEE, B.SC., PH.D.

In very low fields the eddy-current losses in a lamination may be calculated exactly, but the observed loss is always somewhat greater. Most of this extra loss varies with frequency and field in the same way as eddy-current loss, and, if a quantity η equal to the ratio of the observed to calculated loss is defined, it is found that η increases rapidly with decreasing thickness of sheet. It is suggested that this effect arises from neglect of the true mechanism of magnetization, and it is shown that the classical calculation of eddy current loss is invalid when the distance between domain walls becomes comparable with the sheet thickness. Theoretical predictions seem to be in good agreement with observations by Richards, Walker and Lynch.

A Theoretical Analysis of some Errors in Aerial Measurements
Monograph 285 R

J. BROWN, M.A., PH.D.

A theoretical analysis of certain aerial problems is carried out with the help of the idea of a spectrum of plane waves introduced by Booker and Clemmow. The reciprocity theorem, which relates the behaviour of an aerial used for reception to the properties of the same aerial as a transmitter, is used to derive an expression for the power received by one aerial as a result of transmission from a second aerial at any distance from the first. It is shown that under the conditions used in aerial measurements the size of the receiving aerial can influence the errors in measured radiation patterns and power gains. In particular, the side-lobe levels obtained when too small a separation between the aerials is used can either be larger or smaller than the levels for the true radiation pattern. This result differs from that predicted by diffraction theory, which suggests that side-lobe levels measured at too small a distance are always worse than those in the true radiation pattern. Similarly, when the size of the receiving aerial is taken into account, errors in gain measurements are shown to be larger than those predicted by diffraction theory.

Electromagnetic Energy Transfer *Monograph* 286

P. HAMMOND, M.A.

Methods of calculating and measuring the flow of electromagnetic energy are compared and contrasted. The differences

between the low-frequency and high-frequency approach to energy-flow problems is discussed, and suggestions are made to ease the difficulties in the way of students and teachers faced with these apparently irreconcilable differences.

The Concept of Heterogeneous Surface Impedance and its Application to Cylindrical Cavity Resonators

Monograph 287 R

A. E. KARBOWIAK, PH.D.

The concept of heterogeneous surface impedance is introduced. This is defined as an impedance sheet whose surface impedance varies from point to point in an arbitrary manner. The approach is found to yield useful results in a variety of physical situations, and a few applications are illustrated by numerical examples.

Physical heterogeneous impedance sheets are extremely common. Typical examples are provided by resonators built up of several pieces of metals of various conductivities, resonators imperfectly assembled (e.g. by having small gaps between various parts), effects of imperfect machining or annealing, etc.

The formulae developed relate the Q-factor and the resonant frequency of a cavity to its dimensions and the Fourier components of the surface-impedance function, which, in general, may be anisotropic. The analysis is kept as general as possible, and the formulae developed do not exclude any of the practical cases.

In the case of circumferential heterogeneity it is shown that all $E_{m,n,l}$ and $H_{m,n,l}$ modes (other than E_0 and H_0 modes) are unstable unless the $2m$th harmonic of the heterogeneous surface impedance is absent. It is further concluded that such cavities are characterized by a double-humped resonance curve.

With the exception of a few isolated cases (discussed in detail) an axially heterogeneous cavity when supporting any $E_{m,n,l}$ or $H_{m,n,l}$ mode, may be regarded as a homogeneous one whose axial anisotropic component is the sum of the mean value of the surface-impedance function and one-half of its lth harmonic, and whose circumferential component is given by the difference between the mean value of the surface-impedance function and one-half of its lth harmonic.

The Determination of Control System Characteristics from a Transient Response *Monograph* 288 M

J. P. ELLINGTON, B.SC., *and* H. MCCALLION, B.SC., PH.D.

Measured values of the output of a control system are used to form a characteristic equation from which the overall transfer function may be found. To use the method it is necessary to know, or assume, the form of the transfer function, and also to have a knowledge of the input form. In this manner parameters of existing systems may be found either with a view to improving the system or providing data for future designs. A worked example indicates the possible order of accuracy.

Conductivity of Oxide Cathodes. Part 5.—Functional Structure of the Cathode *Monograph* 289 R

G. H. METSON, M.C., PH.D., M.SC., B.SC.(ENG.)

In this Part the oxide cathode operating at 1 020° K is shown as a 2-element device—a thin-film cathodic-core thermionic emitter covered by a relatively massive porous oxide matrix. The thin-film emitter determines the total emission available from the cathode, and the porous matrix settles the potential rise experienced by the current before it emerges into the outer vacuum. This potential rise is shown to depend only on the self-generated electron density within the matrix pores and to be largely independent of emission density from the core emitter.

A Rectifier Modulator with Stable Low Carrier-Leak

Monograph 290 R

E. HANDS, M.SC.

The paper is concerned with the development of a modulator capable of giving much lower stable levels of carrier leak than previously obtained. After consideration of various types of modulator, the conclusion is reached that the constant-current modulator is probably capable of giving the highest stable level of carrier rejection. This modulator consists, essentially, of a ring modulator whose input transformer is, ideally, replaced by infinite-impedance valve generators feeding each rectifier input terminal.

The action of the constant-current modulator is analysed in detail on the basis of small differences in the characteristics of the rectifying elements, and associated topics are discussed. Experimental evidence, obtained by using a carrier frequency of 3 kc/s, largely supports the theoretical analysis.

The modulator, thus developed, is capable of giving carrier leak levels more than 90 dB below the carrier current from each source which are stable with temperature and time. Also, the modulator's action is such that the fundamental component of the carrier leak is not affected by relatively large unbalances in the carrier currents from each source.

Noise-Reducing Codes for Pulse-Code Modulation

Monograph 291 R

J. E. FLOOD, PH.D.

Theory shows that a simple binary pulse-code modulation system does not make the maximum use of a communication channel of given bandwidth and signal/noise ratio. It is suggested that an improvement in output signal/noise ratio can be obtained by modifying the binary code so that errors in its different digits contribute equal amounts of noise power to the output.

The noise contributions of the digits can be equalized by using a greater number of pulses to transmit the more significant digits. However, the resulting increase in bandwidth introduces additional noise which more than offsets the reduced error liability of the digits and so causes a worsening of the output signal/noise ratio. An attempt to equalize the noise contributions of the digits by using a code with a different base for each digit also fails.

It is possible to make the digits of a binary code group contribute equally to the output noise by varying the pulse height or length from digit to digit. An improvement in output signal/noise ratio is then obtained over a range of input signal/noise ratios. The system using pulses of different heights is less complicated than that using different pulse lengths; however, it is more complex than a system using the simple binary code, and it is doubtful if the improvement in signal/noise ratio justifies the additional complexity.

Some Optimum Four-Terminal Networks having given Input and Output Shunt Capacitances *Monograph* 292 R

O. P. D. CUTTERIDGE, M.SC.(ENG.), PH.D.

The paper deals with the open-circuit transfer impedances of low-pass four-terminal networks having given parasitic

capacitances shunted across both input and output terminals. The discussion, in the first instance, is in terms of the poles and zeros of the transfer function, although physical realizations of optimum networks are also derived.

The first part of the paper deals with the adjustment of the driving-point impedances to produce a transfer impedance having a maximum gain level consistent with given pole and zero positions; various cases having two and three poles are considered. In the second part the author obtains optimum pole-zero patterns yielding the maximum gain/rise-time quotients that are consistent with monotonic response.

The Interpretation of the Results of Impulse Breakdown Tests *Monograph* 293 M

R. HANCOX, B.SC.(ENG.), PH.D.

The paper considers a high-voltage impulse-breakdown test procedure consisting of a series of impulses of increasing magnitude leading to breakdown. The results expected from such a test are compared with the variation with voltage of the probability of breakdown for a single pulse.

PAPERS

The Relation between Picture Size, Viewing Distance and Picture Quality with special reference to Colour Television and Spot-Wobble Techniques *Paper* 2540 R: *Part B*

L. C. JESTY, B.SC.

The paper describes experiments to determine the preferred viewing distance for a number of different types and sizes of picture, including 405-line and 625-line monochrome television and a 405-line colour television picture, all with varying bandwidths. The criterion 'preferred viewing distance' proved to be surprisingly consistent and repeatable, and the results obtained indicate that, unless some new development such as receiver picture storage improves matters, the present European standards of television are wasteful of bandwidth. Various methods of using this surplus bandwidth are discussed. The investigation also covered the use of spot-wobble on the 405-line television picture and two television scanning innovations—'synchronous spot-wobble' and 'sampled synchronous spot-wobble'.

To be read on the 19th February 1958

Results of Full-Scale Stability Tests on the British 132 kV Grid System *Paper* 2575 S: *Part A*

F. BUSEMANN, DR.ING., *and* W. CASSON

The paper describes the results obtained from transient stability tests carried out on a section of the British 132 kV Grid system during the summer of 1956. A 56 MVA generator was connected to the main system through a 150-mile line, and faults of various type were applied with the generator on full load. The main purpose of the tests was to check how close network analyser results agreed with actual performance. It was found that the agreement was, in general, very good and some important information was obtained about the characteristics of cylindrical rotor machines which should be of assistance in future analyser studies.

It was found that flux decay, even with voltage regulators, is a factor which alone could result in discrepancies between network analyser studies and actual performance, but that this is largely compensated by the improving effects of damping, additional losses during faults and governor action.

It was also found that in transient tests, with sudden insertion of the line, stability was maintained provided that the excitation was sufficient for steady-state operation with the line. Reactive power consumed by the machine at the steady-state stability limit was about 15% higher than calculated values, owing to saturation effects. During asynchronous operation with open field up to 30 MW the slip remained very low.

To be read on the 6th March 1958

The Organization for Large-Scale Grid System Tests *Paper* 2559 S: *Part A*

F. H. LAST, PH.D.(ENG.), B.SC.(ENG.), E. MILLS *and* N. D. NORRIS

The stability of generating plant on a large interconnected system is a very important consideration of design and operation. Small-scale tests and the development of various types of calculator have provided the machine designer and system planning engineer with useful information, but the ultimate test is that of satisfactory performance in service. Tests on an operational system are very desirable, but before such work is carried out, the operational risks must be weighed against the importance of the results to be obtained.

In 1956 it was decided that such an investigation should be made, and for the first time the Central Electricity Authority carried out steady-state and transient generator stability tests on an operational section of the system. The paper sets out to describe the organization which was established to carry out such tests.

To be read on the 6th March 1958

Direct-Reading Iron-Loss Testing Equipment for Single Sheets, Single Strips and Test Squares *Paper* 2553 M: *Part A*

J. MCFARLANE, B.SC., J. K. DARBY, B.SC.(ENG.), *and* P. MILNE

The paper describes the two basic techniques by which a dynamometer wattmeter may be employed to measure specific iron loss, and shows how these methods have been applied to measurements on Lloyd-Fisher or Epstein samples and to the development of single-sheet testers and single-strip testers. All the equipments give direct readings of flux density, magnetizing force and specific iron loss. The advantages of single-sheet testing are stressed, particularly as a means for grading hot-rolled transformer steel.

To be read on the 11th March 1958

The Control of Flux Waveforms in Iron Testing by the Application of Feedback Amplifier Techniques *Paper* 2554 M: *Part A*

J. MCFARLANE, B.SC., *and* M. J. HARRIS, B.SC.

By the use of a feedback amplifier technique, the voltage appearing across a search coil wound on a ferromagnetic core can be made to follow any desired driving waveform, and the inherent harmonic distortion effects arising from non-linear B/H characteristics are reduced by an amount approximating to the loop gain. The technique is applied in iron-testing circuits and a.c. bridges, to obtain sinusoidal flux waveforms, thereby avoiding errors in loss measurement which would otherwise arise from distortion effects. Three amplifiers are employed in a single-strip tester to obtain uniform magnetization over the length of the strip.

To be read on the 11th March 1958

LIBRARY ACCESSIONS

**Denotes that the publication is also in the Lending Library. The publications cannot be bought through The Institution; the publishers and the prices are given only for the convenience of members.*

BOOKS

BENHAM, W. E., and HARRIS, I. A. 621.385

The Ultra High Frequency Performance of Receiving Valves*

London, Macdonald, 1957. pp. ix, 173. 22 × 14 cm. 28s.

This is a theoretical treatment of the subject, but numerical calculations based on practical values have been introduced. It deals with current in inter-electrode space, the small-signal h.f. characteristics of idealized diodes, triodes and tetrodes, the difference between actual and ideal valves, and the retarding field diode. Discusses valve and circuit elements in linear-circuit analysis. A final chapter deals with valve noise. The book is reviewed on p. 95.

BRECH, E. F. L. 65

Organisation. The Framework of Management*

London, Longmans, Green, 1957. pp. vii, 424. 22 × 14 cm. £2 5s.

Draws chiefly on the medium and medium-large industrial and commercial undertakings. Amongst the subjects discussed are centralization versus decentralization, committees and co-ordination, organization charts, criteria and planning. Illustrated schedules of the duties and responsibilities of leading personnel are given.

CAYWOOD, R. E. 621.316.003

Electric Utility Rate Economics

London, McGraw-Hill, 1956. pp. xx, 236. 23·5 × 16 cm. £3 15s.

A practical guide to the subject which discusses the many economic and technical factors which must be considered in fixing electric utility rates.

COLEBROOK, F. M., and HEAD, J. W. 51

Basic Mathematics for Radio and Electronics. 3rd ed.

London, Iliffe, 1957. pp. 359. 19 × 13 cm. 17s. 6d.

Begins with elementary algebra and leads up through logarithms, trigonometry and vectors to the calculus. Applications to basic electrical circuits are demonstrated and there is a chapter on more advanced mathematics including Heaviside's technique for dealing with electrical problems.

COTTON, H. 621.31

Electrical Technology. 7th ed.*

London, Pitman, 1957. pp. xv, 864. 22 × 14 cm. £2 10s.

This is a completely revised edition. The chapters have been enlarged and their coverage extended and the rationalized MKS system has been adopted. The book will be reviewed in a future issue.

GOLDRING, M. S. 621.039

Economics of Atomic Energy*

London, Butterworth, 1957. pp. 179. 22 × 14 cm. 15s.

A simple explanation of the processes involved in nuclear reactors and the problems and precautions of this new industry. The astoundingly high capital costs of the atomic energy industry have been largely borne as a military expenditure, and estimates of the cost of electricity generated from atomic power tend to ignore this. By-products of the industry are considered in estimating costs. Comparisons with likely future prices of expendable fuels are given.

LECK, J. H. 533.5

Pressure Measurement in Vacuum Systems

London, Institute of Physics, 1957. pp. 144. 24 × 15 cm. £1 10s.

Describes the different methods of pressure measurement in common use and gauge calibration.

LEE, H., and NEVILLE, K. 679.5

Epoxy Resins. Their Applications and Technology*

London, McGraw-Hill, 1957. pp. xi, 305. 23 × 15 cm. £3.

Amongst a wide variety of applications which have been found for these new resins already are their use for castings, potting, encapsulation, sealing, adhesives, and lightweight foams. The physical, chemical, mechanical and electrical properties which make them suitable are described relative to the appropriate ASTM standards. The chemistry of the subject from the manufacturing standpoint is reviewed.

MANN, F. H. 614.8

Safeguards against the Explosion Hazard in Industry*

London, Electrical Times, 1957. pp. 88. 19 × 12 cm. 6s.

Describes the principles and practical aspects of flameproof construction and testing. Discusses intrinsically safe circuits and also pressurization. The danger from dust as well as inflammable liquids and gases, together with approved safety techniques, is indicated.

MEGAW, H. D. 537.226.3

Ferroelectricity in Crystals

London, Methuen, 1957. pp. xi, 220. 22 × 14 cm. 27s. 6d.

An outline of the subject and the concepts involved is followed by an account of the structure and properties of all ferroelectric and antiferroelectric materials at present known. Then the various theories of the subject are discussed. The data given and the bibliographical lists make this book a useful reference work. The book will be reviewed in a future issue.

NEWTON, G. C., GOULD, L. A., and KAISER, J. F. 621–52

Analytical Design of Linear Feedback Controls*

London, Chapman and Hall, 1957. pp. xi, 419. 23 × 15 cm. £4 16s.

This is a fairly advanced work on analytical design theory. The book will be reviewed in a future issue.

OSBORNE, A. L. 621.315.3

Electricity in Building*

London, Batsford, 1957. pp. 160. 22 × 15 cm. 25s.

This book, written in conjunction with the Electrical Development Association, is intended mainly for architects. An outline is given of the basic principles of electricity wiring systems, control gear, etc. Lighting is treated as a part of 'appearance design' as suggested in a recent report. Various systems of space heating are explained and electricity for water heating is dealt with. Domestic, industrial and commercial premises are considered.

SPANGENBERG, K. R. 621.385

Fundamentals of Electron Devices

London, McGraw-Hill, 1957. pp. xii, 505. 23 × 15 cm. £3 15s.

Introductory chapters are followed by a combined treatment of vacuum and semi-conductor diodes and triodes and the physics of their uses as oscillators, amplifiers and photo-electric devices. A separate chapter deals with noise in electron devices.

OTHER PUBLICATIONS

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, INSTITUTE OF THE AERONAUTICAL SCIENCES AND INSTRUMENT SOCIETY OF AMERICA

1957 National Telemetering Conference. Papers Presented at El Paso, Texas, May 27, 28, 29, 1957

New York, A.I.E.E., 1957. pp. vii, 220. 28 × 22 cm. $3.

ASSOCIATION OF SHORT-CIRCUIT TESTING AUTHORITIES

Rules Governing the Short-Circuit Testing of Air-Blast Circuit-Breakers for Alternating Current Systems

London, Association of Short-Circuit Testing Authorities (Inc.), 1957. Publication No. 17, pp. 45. 25·5 × 19 cm. 10s.

BRITISH BROADCASTING CORPORATION

The B.B.C. Riverside Television Studios: Some Aspects of Technical Planning and Equipment by H. C. Nickels and D. M. B. Grubb

London, B.B.C., 1957. Engineering Division Monograph No. 14. pp. 32. 28 × 22 cm. 5s.

GENERAL POST OFFICE

Piezoelectricity

London, H.M.S.O., 1957. pp. x, 369. 28 × 22 cm. £3 15s.

This publication is reviewed on p. 96.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

Recommendations for Fundamental Parameters for Printed Wiri Techniques

Geneva, International Electrotechnical Commission, 1957. Publication No. 97. pp. 7. 30 × 21 cm. 2 Swiss fr.

NATIONAL PHYSICAL LABORATORY

MSF Standard Frequency Transmissions from the United Kingdo

Teddington, National Physical Laboratory, 1957. pp. 4 24 × 15 cm.

ORGANISATION FOR EUROPEAN ECONOMIC CO-OPERATION

The Industrial Challenge of Nuclear Energy. Papers Given Durin the First Information Conference on Nuclear Energy for Manage ment, Paris, April 1957

Paris, OEEC, 1957. pp. 288. 24 × 15 cm. £1 10s.

POINCELET, P.

Sur Plusieurs Phénomènes de Propagation. Sur l'Inexistence d l'Onde de Surface de Sommerfeld (Several Propagation Phenomena The Non-Existence of Sommerfeld's Surface Waves)

Paris, Gauthier-Villars, 1957. pp. 44. 30 × 21 cm. 850 fr.

Elections and Transfers

The following elections and transfers approved by the Council are effective from the 1st January 1958.

ELECTIONS

Associate Members

ADDISON, Colin Edward
BARNETT, Herbert Kurt, B.ENG., M.SC.
BATTLAY, Paul
BEAN, Walter Horace
BELL, Thomas Thornton, B.SC.
BRASH, Robert Alexander, B.SC.
BROWN, Reginald Frederick, B.ENG.
BURKETT, Ronald Henry William, B.SC.
CHABLANI, Hassanand Rijhumal, B.E., PH.D.
CLAYTON, Colin Geoffrey, M.SC.
COOPER, Robert Ion Beverley, M.A., PH.D.
CROMPTON, Edward Wyn
DAVIS, John Richard
EFFENBERGER, Jerzy Alfred, DIPL.ING.
EVANGELIDES, Paul, M.B.E.
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GALL, Maurice Henry Willis, M.A.
GUHA, Pares Chandra, B.SC., B.SC.(ENG.)
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HOCKING, George Frederick
LOWE, Herbert James
LUBBOCK, Sydney Ernest
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WRATHALL, Robert William, B.ENG.

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CUMMINGS, John Thomas
EATON, George William
HENDERSON, William Stevenson
PAPWORTH, John Charles

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AUTERSON, George, B.SC.
BECHERVAISE, Eric Walter
BEVIS, William Frederick
BUTTERWORTH, Hubert
COTTERILL, Leonard James
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FEE, Donald John
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GRAY, John
GRIFFITHS, Henry William Albert
HARDING, Sidney Herbert
HOGAN, Thomas Patrick, B.E.
KNOWLES, Leslie Bruce
LANGLEY, Richard William
MCDOWELL, Robert Leech Sanderson, B.SC.
MARTIN, Charles Adrian Alfred
METSON, Gilbert Harold, M.C., PH.D., M.SC., B.SC.(ENG.)
NUTTING, David Colver, M.B.E., B.SC.

Associate Member to Member (contd.)

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ROBERTS, William Alfred
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SHEARS, Graham Thomas
SWASH, Kenneth Norman, B.SC.
THOMAS, Charles Frank

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Graduate to Associate Member

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BOTTOMLEY, Ralph
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LOVE, David
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MACE, Edwin Hallett, B.E.

Graduate to Associate Member (contd.)

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THORNLEY, John Stanley Thomas
THOROGOOD, Dennis Charles John
TURNER, Basil Amory, B.SC.(ENG.)
TURNER, Lt.-Comdr. Harold Francis, R.N.
VADGAOKAR, Wing-Comdr. Manohar Ganpatrao, B.SC., I.A.F.
VARLEY, Geoffrey
VICKERS, Martin
WARD, Frederick Roy
WARDLE, Harry, B.SC.
WARREN, Alfred John, B.SC.(ENG.)
WATKINS, Derek Charles John, B.SC.(ENG.)
WATSON, Robert James, B.SC.(ENG.)
WHITEHEAD, Ernest Albert
WHITELEY, John Raymond
WIDGERY, Desmond Edward
WIGHTON, John Robert, B.SC.(ENG.)
WILKINS, Eric Lionel
WOOD, Harry
YAXLEY, Graham Milnes

Student to Associate Member

HARVEY, Denis William, B.SC.(ENG.)

The following elections and transfers approved by the Council are effective from the 9th January 1958.

ELECTIONS

Graduates

ALABONE, Christopher
ALLEN, Brian
ALLEN, John
ALLEN, John Alexander William, B.SC.(ENG.)
ALLEN, John Kenneth
ALLEN, Maurice
ALTY, Henry Frederick
ANDERSON, Roger Barry, B.E.
ANDREW, Keith
ANDREWS, Thomas Edward
APPLEBY, James Kenneth John
ARTHUR, Walter Dow Kinnear
ASHE, John George
AVISS, Hugh Wilson
BAILEY, Thomas Joseph
BAKER, Frank
BAMFORD, Herbert, M.SC.TECH.
BARBER, Charles Ronald
BARNACLE, John William
BEALES, Derek Alwyn
BEAUMONT, Peter
BERNSTEIN, Michael Harold, B.SC.
BINNS, John Frederick Howard
BLAND, Philip Charles
BLOUNT, Miss Elizabeth Hilda
BOWDEN, Derek Albert
BOWDEN, Kenneth William
BOWERS, Kenneth Albert
BRAMELLER, Alfred
BRIDGLAND, Reginald John
BRIGGS, Ronald Joseph
BRODIE, David
BROMHEAD, Ronald Charles
BUCKLAND, Frank Antony Max, B.A.
BUNGAY, Dennis Samuel
BURGESS, John Albert, B.E.
BURGESS, John Norman
BURRIDGE, Hubert Timothy
BURTON, Douglas Harold
BUTTERS, Richard Robert
CALLAWAY, Denis Norman
CALLOWHILL, Kenneth
CAMPBELL, Harold
CAMPBELL, Iain Robert
CANNING, Hugh Francis, B.SC.
CATHERALL, John
CAWTHRAW, Maurice John, B.SC.
CHAINANI, Manik Ramchand, B.SC.
CHAPPELL, Richard Arthur
CHEETHAM, John
CHRISTER, Eric Ainsley, B.SC.(ENG.)
CLARKE, Robert Derek
COLLINS, Donald Henry
COLLINS, Edward Herbert
COOKE, Dennis Leslie
COOKE, Robert Geoffrey
COOMBE, Martin Leonard
COPLEY, Douglas Bryan
COWPE, Eric
CROSBIE, Roy Edward, B.ENG.
CULLIFORD, Donald Roy
CUNNINGHAM, Thomas Percival, B.SC.
CURRIE, Hugh
DANGERFIELD, Clifford Edwin
DANIELS, Bryan Schofield
DAVIES, David Trevor Llewellyn, B.SC.(ENG.)
DAWKINS, John
DAY, Alan Keith, B.SC.(ENG.)
DEAN, Norman Harold Ernest
DENSON, Colin Ivor
DENTON, Ronald
DIXON, John
DONALDSON, Harold Francis
DRAPER, Cyril William
DUNKLEY, Pilot Officer Ian, R.A.F.
DURNO, Harry Thomson
EHRENBERG, Wolf, DIPL.ING.
ELLIOTT, Eric
EVERTON, Donald Robert
FAYERS, Deryck John
FERN, Leslie Frank
FISHER, Ian
FLETCHER, Edwin
FLETCHER, James William
FORWARD, Raymond Phillip
FRANKLAND, Owen
GAILEY, George McKenzie
GARBUTT, Michael Henderson
GELL, Terence George
GIBBS, John William
GIRVEN, Alan
GIVEN, Charles Douglas Harper, B.SC.
GOODALL, Walter William
GOODING, George Edward
GOODWIN, John Trevor, B.SC.
GREEN, David
GREEN, Lawrence Young
GREEN, Leslie
GREEN, Raymond Eric
GREENWOOD, Richard
HALES, William Joseph
HALL, William Ernest
HAMAK, Bernard Joseph, B.SC.(ENG.)
HARDING, Anthony Philip, B.SC.
HARPER, John Alfred
HAY, Alexander Robert

Graduates (contd.)

HEAD, John Robert
HERNEN, Brian
HILL, Sylvester Henry
HOONANIAN, Diran Katchik
HORROBIN, George Leslie
HOUGHTON, Paul Goring, B.SC.(ENG.)
HOWARD, Bernard Victor
HUBBARD, Jack
HUGHES, Will
HUGO, Anthony Henry Wouter, B.SC.(ENG.)
HUME, John
HUSTON, John Ashley, B.E.
IRVING, Thomas James Jardine
JAMESON, Walter Stewart
JOHNS, Richard George
JOHNSON, Colin, B.A.
JONES, Edward Newton
KEAR, Brian Spencer Brace
KELLY, George Henry
KHANNA, Man Mohan
KNIGHT, Gerald Aubrey
LEACH, Peter Alan
LEIGH, Frederick George
LIM, Chan Tai, B.SC.(ENG.)
LIMANONDA, Roj, B.SC.(ENG.)
LODGE, John Frederick Arthur
LOWE, Geoffrey
LUCAS, James Matthew
MCCANN, John David
MACGEORGE, David John
MCGUINNESS, Thomas Dennis
MACRAE, Roderick Harold
MAHONEY, Leonard
MARSHALL, William Victor
MAUNG, Ronald Mackenzie Aye, B.A.
MAY, Ronald Arthur
MIDDLETON, John David
MITCHELL, Peter John
MOLYNEUX, Peter Alan
MOORMAN, Richard Slade
MORGAN, Brian
MORLEY, John
MORRISON, David Taylor Thomson, B.SC.
MOTTERSHEAD, Robert
MOUNTFORD, Alan Reginald
MOWATT, Joseph Simpson
NOWLAN, Dennis Thomas
OBERSBY, Alfred Marsh
OGUNTAYO, Emmanuel Adeyemi
PAESLER, Martin Reinhold Alexander, B.SC.(ENG.)
PALMER, Alan Norton
PALMER, Alan Stewart
PANTON, Alexander
PARKER, Lawrence
PARKER, Raymond John
PARKER, William Nicholls
PARKINSON, Robert Waldie
PATEY, Anthony Alfred Frank
PEAK, Peter Eric
PEARSON, John Bryan
PHIPPS, Graham Harry
POOLE, Douglas Edward
PRICE, Edward Robert
PRITCHARD, John Charles
PRYCE, George William Bryan
PRYKE, Geoffrey Albert
PURSER, Kenneth Harry, M.SC.
RAMSDALE, William
RANCE, Arthur William
RENDELL, William Keith, B.SC.(ENG.)
RIPLEY, David James
ROBERTS, Anthony Raymond Varnden, B.SC.
ROBERTS, Michael Desmond
ROBINSON, Derrick Hartley Parkin
ROCKETT, John James
ROSE, Kenneth Edwin
ROWLEY, David John, B.SC.(ENG.)
RYAN, John Anthony, B.E.
SAMPSON, Donald Frederick
SAMUEL, David Byron
SAUNDERS, Terence Keith
SCOTT, Richard
SCOTT, Surtees Alan
SELBY, Barry Clifford
SHARP, Edward Trevor
SHORT, Bernard
SIMMONS, Ramon Israel
SIMPSON, Frederick Arthur
SINCLAIR, Derek Gordon
SMALLEY, Kenneth James
SMITH, Brian Jesse
SMITH, Trevor John
SPINKS, Roy
STAFFORD, Donald
STARR, Francis
STAYTON-DAVIS, Anthony Maurice
ST DENIS, Stewart
STEER, John
STONE, Derick Charles
SWIRE, Kenneth
TAYLOR, Harold John
THACKERAY, Arthur John
THIRKELL, David
THOMAS, Geraint Wynne
THOMBS, Duncan Ulick
THOMSON, David
TICKNER, Gerald Charles
TINKER, Keith Alfred
TOLHURST, Frederick John
TUCKER, Ronald
TURNBULL, Peter Hector George B.SC.(ENG.)
TURNER, Clifford Reginald
TURNER, Jack Nicholas
TYLDESLEY, Edwin David
UZIGWE, Dennis Onuoha
VAISHAMPAYAN, Ramchandra Krishana
VENUS, Ronald Frederick
WARBURTON, Wilfred
WARD, Bryan John
WARD, Francis Brian
WARD, Ronald Vivian
WASSELL, Ronald James
WATSON, Eric Arthur
WATTS, Reginald Albert
WAUGH, Alec Meryven
WHITE, Kenneth
WHITWORTH, Roy Francis
WIGGLESWORTH, David Anthony
WILLIAMS, George Richard
WILLIAMSON, John Morrison
WILSON, Alan Frederick
WILSON, John
WILSON, John Bown
WRIGHT, John
WRIGHT, Paul James

Students

ABATE, Stephen John
AJOSE, Setonji Olufemi
ALTY, John Anthony Rixton
ANSCOMBE, Martin Robert
ARMSTRONG, John Hogarth
ARNOLD, Michael Charles Desborough
ARYEE, Emmanuel Attoh Ahumah
ASPDEN, Harry, B.SC.TECH.
AUSTIN, Malcolm Hugh
BALDRY Ronald Herbert
BARNES, Anthony Michael Preston
BARTON, Marcus Paul
BATEMAN, Michael Conrad
BAXTER, Bryan John
BEATON, Ian James
BEESLEY, Brian
BELL, Geoffrey
BELL, Raymond
BISHTON, Martin Howard
BLAKEMORE, Frederick Norman
BLOOM, Ralph Victor
BODLEY, David William
BOOTH, David Frankland
BOUTNIKOFF, George
BOWLER, Kenyon George Eric
BOWLES, John Patrick
BOWSFIELD, Ralph Clement
BRANDON, Martin
BRENNAN, Patrick Joseph
BRISTOW, Anthony Lawrence
BROWN, Robert Frank
BRUCE-MICAH, Alfred Akotoa
BUCKNER, Frederick Hugh
BURTON, Henry
BUTLER, Robert Gyabaa Jones, B.SC.
CAVANAGH, Eric Joseph, B.A.

Students (contd.)

CHADNEY, Donovan Colin, B.SC.
CHAKRABORTY, Dayamoy
CHAPPLE, Ian Keith
CHOPRA, Kashmiri Lal, B.A.
CHUNGYAN, Glenroy
CLARKE, Philip Michael Edward
COLLETT, Charles Harvey
COLSTON, John Matthew
COODE, Edward John
COOK, Ian Grant
COOKE, Anthony James, B.SC.
COUSINS, John Philip
CROFTS, John William
CROSS, William Thomson
DANIEL, Peter
DANIELS, Michael Hugo
DAVEY, Edward Keith
DAVID, Joseph Haim Hakham
DOUGLAS, James Stuart
DOYLE, Francis John
DRAPER, Geoffrey
DYER, David Charles
DYKE, John Roger
EGAR, Kieran
ELLIS, John Edward
ELSTON, Norman
EMERY, Trevor Reginald John
EVERETT, Denys John, B.SC.
FAIRMANER, Denis
FAULKNER, Michael
FEATHERSTONE, David Hooton
FIELDING, John Graham
FISHER, James Anthony Ernest
FOLKES, Michael Patrick
FONES, Derek Roland
FOXFORD, John Victor
FRANCE, John Trevor
FREMPONG-AMOABENG, Yaw
FRISWELL, Nigel Clive
FULLER, Peter James Arthur
FYNN, Debrah
GILMOUR, Robert
GREEN, Edward Brian Clark
HALL, Graham
HALL, Karl Gerald
HAMILTON, Robert
HAMMOND, Michael
HARDING, John
HEATON, Reginald George
HIRSCHMANN, Henry David
HLAING, Nyunt, B.SC.(ENG.)
HODGES, Anthony Keith
HORNER, Michael Guy
JEFFS, Eric James
JOHNSON, David William
JONES, David John Robert
JONES, Kenneth
KENNEDY, Malcolm William
KING, John Patrick
KING, Raymond
KINSMAN, John Harvey
KVAVIK, Viljar
LAMB, Bryan Charles Gilbert
LANE, Robert Marshall
LANG, Terence
LAWRENCE, Barry Reginald, B.SC.
LAWSON, Denis William
LEWIS, Philip James
L'HERMINIER, Roger Andre
LINDON, Peter
LINGHAM, Paramsothy Vaithia
LOCKLEY, James Alan
LOOKER, Brian John
LUMB, Colin
LUTTERODT, Gerhardt Augustus Haldane
LYALL, James Robert Watt
LYNN, Paul Antony
MCCARTNEY, Brian Stanley
MCCAUGHEY, Patrick Anthony
MCKEE, Graham Benjamin
MANN, Robert John
MASCAS, Kenneth Graham
MAUDSLEY, Kenneth Woods
MEIKLE, James
MILLS, Malcolm
MITCHELL, John Colin
MOGHIS, Shaikh Abdul
MORRIS, Alan
MOYE, Laurence Stanley
MUNRO, Neil
MURRAY, Keith Alexander
NASSER, Costandi Nasri
NEALE, Douglas Frederick
NICHOLLS, John Elliott
NNOLI, Godwin Chukwura
NOONE, Richard, B.SC.
NORTON, Anthony Edward
OBORNE, David Michael
ONUOHA, Emmanuel Alaoma
OYEBOLU, Philip Bolude
PAGE, Derrick John
PAGE, John Stephen
PANNETT, Bryan William John
PAPADAKIS, Andreas Costa
PARAMESVARAN, Thamotharampillai Vaithilingam
PARTRIDGE, Stephen John
PATEL, Jitendra Chinubhai
PEREIRA, Joseph Augustine Terence, B.SC.(ENG.)
PERERA, Peter Edmund
PERRIN, Miss Jane Elizabeth
PETERS, Roy Stanley
POWERS, Patrick
PRINGLE, Gordon
PRINGLE, James Frederick
RAMSAY, Alastair Roderick
REDHEAD, Kenneth
REYNOLDS, Anthony James
RICHES, Brian Edward
RIVERS, Robert Leitch
ROBERTS, John Titus Narh
ROBINS, David Gerald
ROBINSON, Colin
ROSS, David Marshall
ROSS, Frederick Gerald
ROWLANDSON, Gerard Anthony Gillan
RYDING, John
SAGAR, Peter Alan
SAPRA, Parkash Chander, B.A.
SCOTT, Michael
SEFERIAN, Mircea
SENIOR, David Miles
SHAH, Chandra Shekhar
SHARPE, Robin Neville
SHARPE, Terence Clifford
SHEPHERD, Brian
SHERIDAN, Phillip Robert
SIMMONS, John Robert Kenneth, B.SC.
SINGHAKOWINTA, Anek
SKILTON, Roger Henry
SMART, Alan
SMART, Cecil Kenneth
SMITH, Colin James
SMITH, Guy Edmund
STEVENS, Michael James
SYMEONIDES, George
TAYLOR, Alexander Melville
TAYLOR, Graham Christopher
THIRUNAVUKARASU, Sellathurai, B.SC.
THOMAS, Stuart
THOMAS, Terence Haydn
THOMPSON, John Anthony
TOPLISS, John Peter
TRAUB, Harry, B.SC.(ENG.)
TRAYLER, Michael John
TURNER, Archibald Junior
TURNER, Charles William, B.SC.
VINCENT, Leonard George
WAKEFIELD, Donald Keith
WALE, Rodney
WALTER, Arulanandan Rasiahpillai
WARNE, Anthony John
WEBB, Harold George
WHEATLEY, Clifford Walter Robertson
WHIPP, Roger David
WHITE, Keith Alan
WHITELAW, Michael John
WHYSALL, Donald
WIDDOWS, Keith Michael
WILLIAMS, Roy Arthur, B.SC.
WILLIAMS, William Peter
WILSON, Derek
WILSON, James Kobina
WILSON, Robert
WRIGHT, Anthony
WRIGHT, Geoffrey John
YIP, Garlam
YOUNGER, Graeme William
ZORBAS, Nicholas

TRANSFERS

Student to Graduate

AARON, Peter, B.SC.
ANASTASIADES, Christos Genethliou
ARCHENHOLD, Wolfgang Friedrich, B.SC.
BAILEY, John Louis Bevan
BAILEY, William Dalziel
BARTLETT, Kenneth Ivor, B.SC.(ENG.)
BASU, Amal Endu, B.SC.
BELL, Gerald William
BENNETT, Peter John
BIDWELL, Brian Alfred
BISWAS, Amiya Kumar, B.SC.
BLOXHAM, David Arthur
BOOTE, Gordon
BOWLER, Peter Ridgeway, B.SC.(ENG.)
BRADLEY, Geoffrey Alan, B.SC.
BRANCHFLOWER, Alan James
BRANFORD, Ronald
BRECKNELL, Geoffrey William Jackson, B.SC.(ENG.)
BRENTFORD, Malcolm, B.SC.TECH.
BRIDGE, Rodney James
BROWN, Graeme Malcolm, B.E.
BROWN, Russell, B.ENG., PH.D.
BRYAN-BROWN, David
BUCKTON, Colin James, B.SC.(ENG.)
BURDES, John Proom
BURROWS, Gordon Harry
CARTER, John Leslie
CARVALHO, Anthony Sylvester, B.SC.(ENG.)
CHASE, Brian Collison, B.E.
CHAUHAN, Sub.-Lt Nand Kumar Singh, B.A., B.SC., I.N.
CLARE, Philip Ian, B.SC.
CLARKE, Raymond William, B.SC.(ENG.)
CLEMO, Richard Philip David
COKER, Derek John
COOKNELL, Frank
COOPER, Brian, B.SC.
COURTNEY, Sub.-Lt. Graham Sidney, B.SC.(ENG.), R.N.V.R.
CROMBLEHOLME, Herbert Michael B.SC.TECH.
DAVIES, Charles Aneurin, B.SC.
DAVIES, Michael Burchell
DEAN, Kenneth John, B.SC.
DEMPSEY, Hartpole Baxter
DENYER, Peter Charles
DODSON, John
EDWARDS, Emrys
ELVEY, Norman Walter
EVANS, David
EVANS, Ellis Ivor
FARAZMAND, Bahman, B.SC.
FARNELL, Gerald Peter
FARRAR, Kenneth
FLETCHER, Derek, B.A.
FRENCH, Michael Hutt, B.SC.(ENG.)
GALE, William Melville, B.SC., B.E.
GALPIN, Pilot Officer Robert Keith Portway, B.SC.(ENG.), R.A.F.
GARDNER, Pilot Officer Cyril Desmond Allen, R.A.F.
GARRARD, Ronald Neale
GASHUS, Ove Kristoffer, B.SC.
GAVIN, Michael Sean, B.SC.(ENG.)
GEERE, Desmond Hubert, B.SC.(ENG.)
GIBBS, John Martin
GILES, Ian Gordon
GILLING, Geoffrey
GLOVER, David
GOULD, Norman John
GOYAL, Jagdish Prasad, B.E., B.SC.(ENG.)
GUTTRIDGE, Josiah, B.SC.(ENG.)
HALL, John Charles
HAMMERSLEY, David Anthony, B.SC.
HARDING, George Edward
HARVEY, Peter John
HARVEY, Robert Graeme, B.E.
HAYES, Roy Ernest, M.SC.
HIBBERD, Kenneth William
HILLAS, Michael Joseph
HO, Hin Hung
HODGSON, David
HODGSON, John Ernest, B.SC.(ENG.)
HOGG, James Pitcairn
HUDDLESTON, William
JAMES, Thomas William, B.SC.
JEFFS, John Trevor
JONES, Henry Kelvin
JONES, Peter Ronald
JONES, Tudor Morris, B.SC.
KADIR, Shamsuddin Bin Abdul
KEMHADJIAN, Henry, B.SC.(ENG.)
KYBETT, John Trevor, B.SC.(ENG.)
LANE, Kenneth Robert
LATHAM, Richard Patrick Gwyn
LEACH, Richard
LEWIS, Derek
LINGLEY, Peter James
LISTER, Brian, B.SC.(ENG.)
LITTLE, Geoffrey Ernest
MCCULLOUGH, David, B.SC.
MCFARLANE, James Dobbie
MACKENZIE, Donald, B.SC.(ENG.)
MARSHALL, Maurice Richard
MARTIN, John David, B.SC.(ENG.)
MATHER, Brian, B.SC.
MEESON, John Kenneth
MERRION, Robert Alan
MILBURN, Peter Anthony
MOORE, Lawrence, B.SC.(ENG.)
NEW, William Ernest
NICOL, Andrew William, B.SC.
ORRISS, John
OWEN, Robert
OXTOBY, Keith Hirst
PAGE, Roger Francis Scott
PAICE, Derek Albert
PALMER, Bryan
PARKES, Michael Edward
PARNELL, James Crawford
PEET, John Dennis, B.SC.TECH.
PHELPS, Griffith Emlyn
PLATER, Gerald George
PORRITT, Frank Lindsley
PRATLEY, John Brian
RAGI, Abbas Ali
REES, Raymond
REID, Anthony Alexander
REYNOLDS, John Spackman, B.SC.
RHODES, Norman Clifford
RICHARDS, Geoffrey Charles
RICHARDS, Malcolm John
ROGERS, Robert Henry
ROLLS, Reynold Gilbert
ROMANG, Anthony John
ROSE, David William
ROSS, Iain
SECKER, Philip Edward, B.SC.(ENG.)
SHAH, Harshavadan Kirtanlal, B.SC.
SHISHAKLY, Said Wadie
SIMPSON, Archibald William, B.SC.
SMITH, Alan Russell
SMITH, Colin Morice
SMITH, Geoffrey
SMITH, Kenneth Boyd
SMYTH, Nicholas David
SOAMES, Spencer Thomas
SPENCER, James William
STEWARD, John Emeny
STINSON, John Keith
SYMONS, Owen Charles, B.SC.TECH.
TANNER, Peter Leonard
TATE, Maurice
TAYLOR, Leonard
TELFORD, Thomas, B.SC.
THOMAS, Leslie
TILSTONE, George
TONG, Jonathan Felix
TONGE, Alan Sydney
TOWNSEND, Derek
TUPPER, George Ivor Frederick
VAN DER WEYDEN, Paul Romer
VINCENT, Brian Jeffrey
VOSS, Walter Arthur Geoffrey, B.SC.
WALKER, Hugh, B.SC.
WALKER, William Stewart
WEDDELL, Ronald Kenneth
WELFORD, John Leonard
WELLER, James Raymond
WILLIAMS, Peter Lionel, B.SC.
WILLIS, Desmond Bryan, B.SC.(ENG.)
WILSON, Joseph Eric
WILSON, Philip Norman
ZAKI, Mohamad

Forthcoming Events at Savoy Place

All meetings are held at Savoy Place, beginning at 5.30 p.m. (tea at 5 p.m.), except where otherwise stated. The nature of the meeting is indicated by the following key:

E EDUCATION DISCUSSION CIRCLE
I INFORMAL
M MEASUREMENT AND CONTROL SECTION
O ORDINARY
R RADIO AND TELECOMMUNICATION SECTION
S SUPPLY SECTION
U UTILIZATION SECTION

After each paper that has now been published is added the month that a synopsis has appeared in the *Journal* under 'Monographs and Papers published individually this month', i.e. about the time the paper has been published as a separate. A paper that has not yet been published will be available at least ten days before the meeting at which it will be read.

February 1958

M **18** *Tuesday* C. D. MEE, PH.D. 'Magnetic Tape for Data Recording' (Paper No. 2536 M) *Synopsis:* January 1958 (To be read by J. F. Doust)

R **19** *Wednesday* L. C. JESTY, B.SC. 'The Relation between Picture Size, Viewing Distance and Picture Quality with special reference to Colour Television and to Spot-Wobble Techniques' (Paper No. 2540 R) *Synopsis:* see p. 100

R **24** *Monday* Informal Evening on 'Stereophonic Recording on Gramophone Discs' at which there will be a talk given by H. A. M. Clark, B.SC.(ENG.)†

S **26** *Wednesday* P. RICHARDSON 'Design and Application of Large Solid-Rotor Asynchronous Generators' (Paper No. 2492 S) *Synopsis:* January 1958

27 *Thursday* Annual Dinner (At Grosvenor House, Park Lane, W.1, at 7 for 7.30 p.m.)

March 1958

E **4** *Tuesday* K. R. STURLEY, PH.D., B.SC., will open a discussion on 'Some Impressions of Technical and Industrial Training in the United States'* (At 6 p.m. tea at 5.30 p.m.)

O **6** *Thursday* F. BUSEMANN, DR.ING., *and* W. CASSON 'Results of Full-Scale Stability Tests on the British 132 kV Grid System' (Paper No. 2575 S) *Synopsis:* see p. 100

F. H. LAST, PH.D.(ENG.), B.SC.(ENG.), E. MILLS, *and* N. D. NORRIS 'The Organization for Large-Scale Grid System Tests' (Paper No. 2559 S) *Synopsis:* see p. 100

I **10** *Monday* MISHA BLACK, O.B.E., will open a discussion on 'The Industrial Designer—an Ally or Enemy of the Engineer?'*

M **11** *Tuesday* H. BLOMBERG *and* P. J. KARTTUNEN 'A Ferrometer for the Determination of the A.C. Magnetization Curve and the Losses of Small Ferromagnetic Sheet Samples' (Paper No. 2482 M) *Synopsis:* January 1958 [To be read by Professor F. Brailsford, PH.D., B.SC.(ENG.)]

J. MCFARLANE, B.SC., P. MILNE, *and* J. K. DARBY, B.SC.(ENG.) 'Direct-Reading Iron-Loss Testing Equipment for Single Sheets, Single Strips and Test Squares' (Paper No. 2553 M) *Synopsis:* see p. 100

J. MCFARLANE, B.SC., *and* M. J. HARRIS, B.SC. 'The Control of Flux Waveforms in Iron Testing by the Application of Feedback Amplifier Techniques' (Paper No. 2554 M) *Synopsis:* see p. 100

SM **12** *Wednesday* BERYL M. DENT, M.SC., E. R. HARTILL, B.SC.(ENG.), *and* J. G. MILES, B.SC.(ENG.) 'A Method of Analysis of Transformer Impulse Voltage Distribution using a Digital Computer' (Paper No. 2452 S) *Synopsis:* December 1957

U **13** *Thursday* D. L. SMART, B.SC.TECH., *and* J. J. L. WEAVER 'The Use of Steel-Tank Mercury-Arc Inverters for Generating Medium Frequencies for Induction Heating' (Paper No. 2457 U) *Synopsis:* January 1958

R **19** *Wednesday* K. W. CATTERMOLE, B.SC. 'Efficiency and Reciprocity in Pulse-Amplitude Modulation. Part I—Principles' (Paper No. 2474 R) *Synopsis:* December 1957

J. C. PRICE, B.SC. 'Efficiency and Reciprocity in Pulse-Amplitude Modulation. Part II—Testing and Applications' (Paper No. 2475 R) *Synopsis:* December 1957

K. W. CATTERMOLE, B.SC. 'Transistor Pulse Generators for Time-Division Multiplex' (Paper No. 2577 R)

O **20** *Thursday* R. L. BEURLE, PH.D., B.SC.(ENG.) Lecture on 'Storage and Manipulation of Information in the Brain'‡

RM **21** *Friday* Joint Dinner-Dance (At the Café Royal, at 7 for 7.30 p.m.) (Particulars issued with the January *Journal*)

M **25** *Tuesday* L. ESSEN, D.SC., PH.D. Lecture on 'The Atomic Clock'†

S **26** *Wednesday* PROFESSOR F. GIORDANI Lecture on 'The Objective for Euratom'‡

R **27–28** *Thursday–Friday* Convention on 'Radio Aids to Aeronautical and Marine Navigation' (Full details and registration form obtainable from the Secretary)

R **31** *Monday* Informal Evening on 'Future Radiocommunication Methods for Civil Aircraft', at which there will be a talk given by W. E. BRUNT†

* No advance information will be available and no Press report will be permitted.
† An abstract will be available in advance.
‡ No advance information will be available.

Forthcoming Events at Savoy Place *(contd.)*

April

E **1** *Tuesday* D. J. BOLTON, M.SC.(ENG.) will open a discussion on 'Economic Aspects of Electrical Engineering'* (At 6 p.m., tea at 5.30 p.m.)

R **9** *Wednesday* Informal Evening on 'U.H.F. Test Transmissions'

O **10** *Thursday* J. A. RATCLIFFE, O.B.E., M.A., F.R.S. Lecture on 'Radio Observations on Artificial Satellites'‡

I **14** *Monday* FORBES JACKSON will open a discussion on 'The Future Trend of Installation Inspection'*

MU **15** *Tuesday* PROFESSOR E. BRADSHAW, M.B.E., M.SC.TECH., PH.D., M. WAGSTAFF, M.SC.TECH., *and* F. COOKE 'A Train Performance Computer' (Paper No. 2425 M) *Synopsis:* November 1957

J. F. MEREDITH, B.SC., *and* E. A. FREEMAN, B.SC. 'The Simulation of Distributed-Parameter Systems, with particular reference to Process Control Problems' (Paper No. 2376 M) *Synopsis:* July 1957

J. L. DOUCE, M.SC., PH.D., *and* J. C. WEST, PH.D., B.SC. 'A Magnetic-Drum Store for Analogue Computing' (Paper No. 2393 M) *Synopsis:* July 1957

S **16** *Wednesday* (In conjunction with the British Nuclear Energy Conference) K. L. STRETCH, M.A. 'Operational Experience—Calder Hall' (Paper No. 2594 S)

* No advance information will be available and no Press report will be permitted.
† An abstract will be available in advance.
‡ No advance information will be available.

British Nuclear Energy Conference: Forthcoming Programme

Details of two forthcoming meetings of the British Nuclear Energy Conference are given below. They will be held at 5.30 p.m., with tea at 5 p.m.; tickets of admission are not required.

1958

MARCH 18 *Tuesday*

Sponsoring society and place of meeting: The Institution of Civil Engineers, Great George Street, London, S.W.1.

James Forrest Lecture on FURTHER DEVELOPMENTS IN NUCLEAR POWER

Sir John Cockcroft, O.M., K.C.B., C.B.E., F.R.S.

APRIL 16 *Wednesday*

Sponsoring society and place of meeting: The Institution of Electrical Engineers, Savoy Place, London, W.C.2.

OPERATIONAL EXPERIENCE—CALDER HALL

K. L. Stretch, M.A.

Advance copies will be available not later than ten days before the meeting from the Secretary of The Institution of Electrical Engineers.

District Meetings

Arrangements for District Meetings in March other than those in the area of a Local Centre.

March 1958

MAIDSTONE (At the Medway College of Technology, Maidstone Road, Chatham, at 6.30 p.m. for 7 p.m.)

3 *Monday* Informal Evening on 'Electronics and Automation'. Talk by H. A. Thomas, D.SC., on 'Some Industrial Applications'

BEDFORD (At the Swan Hotel, at 7.15 p.m., tea at 6.30 p.m.)

11 *Tuesday* R. J. HALSEY, C.M.G., B.SC.(ENG.) 'The Transatlantic Telephone Cable'

OXFORD (At the Southern Electricity Board, 37 George Street, at 7 p.m.)

12 *Wednesday* F. J. LANE, O.B.E., M.SC. 'High-Voltage D.C. Transmission with special reference to Cross Channel Cable'

HATFIELD (At Hatfield Technical College, Roe Green, at 7 p.m., tea at 6.15 p.m.)

27 *Thursday* A. DOUGLAS 'Electrical Synthesis of Music'

Contents of the Current Issues of the *Proceedings*

The date in italics is that of the Journal review or special article.

PART A. POWER ENGINEERING (FEBRUARY 1958)

T. E. GOLDUP, C.B.E.
Inaugural Address *January 1958*

PROFESSOR M. G. SAY, PH.D., M.SC.
Supply Section: Chairman's Address *November 1957*

H. S. PETCH, B.SC.(ENG.)
Measurement and Control Section: Chairman's Address *November 1957*

Centre, Sub-Centre and Group Chairmen's Addresses

Discussion on **The Willis Jackson Report 'The Supply and Training of Teachers for Technical Colleges'** before an Ordinary Meeting of The Institution

J. H. WALKER, M.SC., PH.D., AND N. KERRUISH, M.A. PAPER NO. 2423 S
Parallel Operation of Two Synchronous Machines

PROFESSOR G. H. RAWCLIFFE, M.A., D.SC., AND N. L. GARLICK. PAPER NO. 2443 U
Two Improved Chorded Windings for 3: 1 Pole-Changing *January 1958*

W. HOLTTUM, M.ENG. PAPER NO. 2484 U
The Case for Open Installation for Metal-Sheathed Cables, with some notes on Construction *February 1958*

PART B. RADIO AND ELECTRONIC ENGINEERING (JANUARY 1958)

See the Journal for January 1958, p. 46.

PART C. MONOGRAPHS (SEPTEMBER 1957)

See the Journal for September 1957, p. 525.

ANNOUNCEMENTS TO MEMBERS

THE HOMES FUND

SUMMARY OF CONTRIBUTIONS RECEIVED TO 25TH JANUARY 1958

	No. of Contributors	£	*s.*	*d.*
£1 000 and over	6	6 000	0	0
£100 to <£1 000	30	6 586	3	0
£5 to <£100	849	9 027	11	7
£2 to <£5	2 041	5 572	18	11
Under £2	22 797	11 900	10	5
		£39 087	3	11

HONOURS AND DISTINCTIONS CONFERRED ON MEMBERS

The names of the following members of The Institution were included in the list of New Year Honours and Distinctions conferred by Her Majesty:

KNIGHT GRAND CROSS OF THE ORDER OF THE BRITISH EMPIRE

Yarrow, Sir Harold E., Bart., C.B.E. (*Companion*).

COMMANDER OF THE ORDER OF THE BRITISH EMPIRE

Ball, E. H. (*Member*).
Barraclough, Alan, B.SC. (*Member*).
Mason, J. A. (*Member*).
Pulling, M. J. L., O.B.E., M.A. (*Member*).

OFFICER OF THE ORDER OF THE BRITISH EMPIRE

Chew, W. G. N. (*Member*).
Dell, R. (*Member*).
Elford, Lt.-Col. E. N., T.D., R.A. (*Associate Member*).
Fitzer, H. C., B.SC.(ENG.) (*Associate Member*).
Gillies, J. F., PH.D., B.E., B.SC.(ENG.) (*Member*).
McMahon, R. A. (*Member*).
Rowe, E. G., M.SC. (*Member*).
Smith, W. E. (*Member*).
Welch, L. H., B.SC.(ENG.) (*Member*).

MEMBER OF THE ORDER OF THE BRITISH EMPIRE

Lloyd, Harold (*Member*).
Thwaites, J. E. (*Member*).

FIFTY YEARS OF MEMBERSHIP

The Council take much pleasure in placing on record the completion of fifty years of membership of The Institution by the members whose names appear below; they first became associated with The Institution in the year 1908.

Abbott, J. R.
Arnott, J. W.
Bamford, P. E.
Barney, Sqdn.-Ldr. L. W.
Barton, Capt. R. G.
Bax, H. E. I.
Bollam, Major C.
Boyer, J. R.
Brander, J.
Brook, Lt.-Col. R. V. C., O.B.E.
Burgess, W. A. A.
Chetty, C. V. K., M.B.E., B.A., B.SC.TECH.
Choksey, K. P.
Clark, W.
Cockshott, E. H.
Cole, F. A.
Cole, G. W.
Collins, A., M.B.E., B.SC.(ENG.)
Comerford, E.
Cooch, H.
Cooper, J. S. St. G., M.A., B.SC.
Crompton, A. W.
Cross, Capt. H., M.B.E., M.C.
Dalmer, I.
Davies, J.
Davies, P. L.
Dent, A. E.
Dinham-Peren, A. E. H.
Dixon, T. A. F., O.B.E.

Fifty Years of Membership (contd.)

Doran, J. G.
Eaton, R. N.
Edwards, E. G.
Fletcher, R. W. J.
Franklin, G.
Gardner, A., B.SC.
Garrett, W. B., B.SC.TECH.
Gifford, R. D., D.SC., F.R.A.S.
Goodall, J. M.
Gow, A. G.
Grimes, The Venerable C. J., D.D.
Gundry, A. R.
Hacking, Sir John
Hall, T.
Helme, G. S., T.D.
Higgins, Capt. C., O.B.E., B.SC.(ENG.)
Hills, S. M.
Hollingworth, J., M.A., D.SC.(ENG.)
Hurst, T. H.
Hutt, A., M.B.E., B.SC.
Jack, H., B.SC.
Jockel, L. M.
Keelan, Col. R. E., O.B.E., M.C., T.D., R.E.
King, F. A., C.B.E.
Langton, J. L., M.SC.
Lee, Sir George, O.B.E., M.C.
Long, Major R. F., M.C., R.E.
Low, D. W., B.SC.
McCall, W. T., M.SC.
Matthews, L. J.
Medforth, G. T.
Parrott, R. G.
Paton, G. K.
Peel, M. L.
Phillips, E. G., O.B.E., M.A.
Poole, H. E.
Porter, T. Y.
Reay, G. H. N.
Ridsdale, J. L. D.
Robertson, A. T.
Rogers, W. L. A.
Rye, A. N.
Scampton, G. O.
Sellens, F. C.
Sherwood, F. G.
Shipley, J. F.
Sichel, G. M., B.SC.
Smith, C. W.
Thompson, H. S., C.B.E.
Tufnell, C. P.
Vincent, J. D. A.
Walshe, J. M., M.B.E.
Weaver, H. G.
Webb, E. H.
Williams, H., B.SC.TECH.
Willoughby, G. P., O.B.E., M.SC.TECH.
Yeates, A. C.

DISCUSSIONS AT MEETINGS

The Council desire it to be understood that contributions to the discussions at meetings should not be read from manuscript, since they consider that this form of presentation is contrary to the true spirit of a discussion.

WRITTEN CONTRIBUTIONS TO DISCUSSIONS

Members who are unable to be present at a meeting, or who, if present, do not have an opportunity of speaking, may submit written contributions to the discussion which will be considered for publication in the *Proceedings*. This does not apply to Informal Meetings or Discussion Meetings.

We would also remind members that written contributions on papers published in the *Proceedings* without being read at meetings will be considered for publication.

Members should note that the Papers Committee have been obliged to set a limit of 300 words for contributions of either sort.

COMMUNICATIONS FROM OVERSEA MEMBERS

Oversea members are specially invited to submit, for publication in the *Proceedings*, written communications not exceeding 300 words on papers read before The Institution or published in the *Proceedings* without being read. The contributor's country of residence will be indicated. Brief articles, items of news and photographs intended for the *Journal* will also be most welcome.

Copies of all papers read before The Institution are sent to each Oversea Representative of the Council for distribution to members likely to be in a position to submit communications.

PROCEEDINGS AND *SCIENCE ABSTRACTS*

OUT-OF-PRINT NUMBERS

The Secretary would be glad to receive copies of the following issues of the *Proceedings* and *Science Abstracts*. Subscribers are invited to return their copies to him in order that the gaps in the stock of back numbers can be filled. Payment would be made at the rate of 5s. for the *Proceedings* and 2s. 6d. for *Science Abstracts*, for each copy in good condition, plus postage.

Proceedings

1954 Vol. 101 Part 1 No. 127

Science Abstracts

Section A (Physics)

1956	Vol. 59	January to June	Nos. 697 to 702
1956	Vol. 59	August to December	Nos. 703 to 708
1956	Vol. 59		Index Number

Section B (Electrical Engineering)

1956	Vol. 59	January, February	Nos. 697, 698
1956	Vol. 59	April to August	Nos. 700 to 704
1956	Vol. 59	October	No. 706
1956	Vol. 59	December	No. 708

ELECTROMAGNETISM AND RELATIVITY

Attention is called to the review on p. 95 of Professor E. G. Cullwick's recent book on 'Electromagnetism and Relativity, with particular reference to moving media and electromagnetic induction'. Assistance with the publication of this work has been given to the author by the Technical Publications Panel of The Institution, and the publishers state on one of the preliminary pages that the book is published 'with the co-operation of The Institution of Electrical Engineers'.

NATIONAL TELEMETERING CONFERENCE 1958

A National Telemetering Conference will be held in Baltimore, Maryland, U.S.A., in June 1958. The papers presented and discussed will deal with telemetering techniques and systems and their industrial, medical and nuclear applications. There will be an exhibition of technical advances in telemetering art, as well as a banquet and other social functions. Those wishing to contribute a paper must submit its title as soon as possible and two copies of an abstract by the 18th March. Further details may be obtained by writing to Mr. W. J. Mayo-Wells, National Telemetering Conference 1958, 3830 Beecher St. N.W., Washington, 7, D.C., U.S.A.

THE UNIVERSITY OF DURHAM APPEAL

The University of Durham is appealing for funds to help with the re-equipment and expansion of the scientific laboratories in the Durham Colleges. The intended alterations are directed particularly towards increasing the annual output of graduate physicists and chemists. Electrical organizations (particularly those employing physicists or chemists) and any graduates of Durham University who are interested in the scheme are invited to get in touch with Sir James Duff, The Warden, The Durham Colleges, 38 North Bailey, Durham.

INTERNATIONAL STUDY DAYS ON MODERN POWER PLANTS

The Association des Ingénieurs Électriciens sortis de l'Institut Électrotechnique Montefiore is organizing from the 27th to 31st May 1958 some International Study Days on Modern Thermal and Hydraulic Power Plants, which will be held in Liège, Belgium. The Conference will be divided into four sections, dealing with boilers, steam turbines, hydraulic turbines and alternators. The official languages will be French, English and German, and instantaneous translation will be available to those attending the meetings. The programme includes tours and technical visits and, in particular, a visit to the Brussels International Exhibition.

Preliminary reports by American, Belgian, British, French, German and Swiss authors will be published before the opening of the meeting. The registration fee, which entitles a participant to the reports of one section, is 600 Belgian francs. Further particulars may be obtained from the Secretary, International Study Days, 1 rue de Spa, Liège, Belgium.

PORTRAIT OF G. R. KIRCHHOFF

In accordance with its tradition of publishing annually a portrait of a pioneer of communication engineering, the Union internationale des télécommunications has recently issued an etching of G. R. Kirchhoff. Like previous portraits in the series, it is printed on art paper and measures 23 cm × 17 cm. It may be obtained from the Secrétariat générale de l'Union internationale des télécommunications, Palais Wilson, 52 rue des Pâquis, Geneva, price 3 Swiss francs (post free). Copies of the portraits issued in previous years are also available.

WORLD POWER CONFERENCE: SECTIONAL MEETING IN MONTREAL

The theme of the Sectional Meeting of the World Power Conference, to be held in Montreal from the 7th to 11th September 1958, will be 'Economic Trends in the Production, Transportation, and Utilization of Fuel and Energy'. The Papers Committee, under the chairmanship of Sir Josiah Eccles, have arranged for sixteen papers to be presented by the British National Committee, and a list of these papers is now available. The programme for the meeting, with membership and other application forms, will be ready very shortly. Inquiries about this should be addressed to The Secretary, British National Committee, World Power Conference, 201 Grand Buildings, Trafalgar Square, London, W.C.2.

LECTURES ON MAGNETIC AMPLIFIERS AT BRISTOL

The Bristol College of Technology has arranged a post-graduate course of lectures on 'Magnetic Amplifiers' which is designed for engineers employed in industry and in research; the course will survey basic principles and applications. The lectures will be given on the evening of Friday, 7th March, and on Saturday, 8th March, by Dr. E. H. Frost-Smith. The fee for the course (exclusive of accommodation and meals) is £2 2s. Those interested should apply immediately to the Organizer of Short Courses, The College of Technology, Ashley Down, Bristol 7, from whom further particulars may be obtained.

METALLURGICAL ASPECTS OF SEMI-CONDUCTORS

A SYMPOSIUM AT BIRMINGHAM

The Institute of Metals is organizing a one-day symposium on 'Metallurgical Aspects of Semi-Conductors', which will be held on the 25th February at the College of Technology, Gosta Green, Birmingham. Some short papers will be presented, but copies of them will not be available before the meeting. Visitors will be welcome and admission will be without ticket. Further particulars may be obtained from the Secretary of The Institute of Metals, 17 Belgrave Square, London, S.W.1.

SPECIAL COURSES IN HIGHER TECHNOLOGY

The programme of specialized courses at technical colleges in London and the Home Counties for the spring and summer terms 1958 has recently been published. The courses are mainly part-time and do not appear regularly in college calendars or prospectuses. They cover a wide range of advanced subjects, and the fees vary from 10s. to £2, depending on the number of lectures. Those interested will find further details in the 'Bulletin of Special Courses in Higher Technology, 1957–58, Part II', issued by the Secretary, Regional Advisory Council, Tavistock House South, Tavistock Square, London, W.C.1, price 3s. post free.

BRITISH ELECTRICAL CONFERENCE

The British Electrical Conference, which was briefly noted in last September's issue, will be held in Brussels on the 16th and 17th May 1958—one month after the opening of the Universal and International Exhibition. The two meetings of the Conference will take place in the Exhibition Auditorium.

Membership of the Conference is restricted to representatives nominated by associations and firms supporting the collective exhibit. Hotel accommodation will be available for members of the Conference, but it is essential that early indication should be given of the type of accommodation required.

Delegates will assemble at Brussels on the 15th May. At the first meeting of the Conference, on Friday morning, the 16th May, Sir Gordon Radley will read a paper on 'Communication between Nations and Peoples', and at the second meeting, on Saturday afternoon, the 17th May, Sir John Cockcroft will deliver a paper on 'Nuclear Energy, the Power of the Future'. The Conference will end with a reception of members on Saturday evening.

Further details may be obtained from the Organizing Secretary, British Electrical Conference, 36 Kingsway, London, W.C.2.

GRANTS FOR GRADUATES

The Department of Scientific and Industrial Research will again offer awards this year for post-graduate training in science and technology. A new edition of 'Notes on D.S.I.R. Grants for Graduate Students and Research Workers' (H.M.S.O., 1s. 6D.) provides full details of the scheme.

Last year, 649 new Research Studentships were awarded by D.S.I.R. in addition to those which were renewed for second and third years. Also, 152 of the newly introduced Advanced Course Studentships were awarded. The Department hopes this year to be able to make at least as many new awards as in 1957.

The values of these studentships remain much the same as last year—but certain students now qualify for additional awards two years earlier than previously. This innovation is mainly to attract those with useful industrial backgrounds to undergo training in methods of research without a considerable drop in salary.

Forms of application for studentships are supplied only to senior staff of departments of science and technology in universities, colleges and other approved establishments. Candidates over the age of twenty-seven are not usually accepted for studentships. The Department will in future consider the payment of allowances for dependents in certain instances.

The booklet mentioned above also explains two other schemes: D.S.I.R. Research Fellowships for outstanding young investigators already trained in methods of research; and grants for special researches to allow investigators of acknowledged standing to initiate and develop promising research work.

THE ELECTRIC RAILWAY SOCIETY

Railways have a fascination for numerous people who may know little about them or rarely use them. Perhaps such fascination often stems at least partly from childhood enjoyment of a model train set, but there is more behind it than that: enthusiasm for constructional toys, such as Tinkertoy and Meccano, does not necessarily develop into any lasting interest in the work of the civil engineer. The cult of railways has indeed something in common with the cult of the veteran or vintage car. In both may be found a mixture of appreciation of former enterprise and fine engineering, interest in performance, and nostalgic certainty that the golden age in Britain of mechanical transport was long ago. But the throbbing steam locomotive, with its whirling wheels and billowing exhaust plume, is still with us, and it alone must contribute significantly to adult interest in railways, through the glamorous impression which it leaves on ear and eye. Not so at present the motor-coach on the London Tube, or a Manchester–Sheffield electric locomotive.

Sir Brian Robertson, speaking in January 1955 about the British Transport Commission's modernization plan, implied that the Commission was not blind to the value of railway fascination as a constituent of goodwill between travellers and British Railways. He said, in referring to the end of building steam locomotives, 'We are honestly seeking a means to avoid losing all the romance which has attached to this great iron horse'. (The Publicity Officers of British Railways have, unfortunately, done singularly little to cultivate such romance in the three years that have since elapsed.) But, as the quiet, if good-looking, electric locomotive and the rather soulless motor-coach trains become more widespread, the preservation of railway fascination will not be easy. Does the key lie in the emergence of a new type of fascination—for the bustling competence with which electric railways handle dense traffic?

It was in fact the articulate emergence of such a fascination which led to the founding of the Electric Railway Society in 1946. By now a well-established body, it caters especially for those interested, professionally or otherwise, in electric railways. It is not a crowd of juvenile enthusiasts; it encourages a discriminating approach to its subject. Talks on a variety of topics, e.g. 'Rectifier Locomotives' and 'American Impres-

sions' (the latter with colour films), are presented at the monthly meetings in London, and appropriate visits form part of the annual programme. Branches are now being started in the Provinces.

The Society publishes a two-monthly journal, with original articles on the engineering, operation, history, and even sociology, of electric railways; it includes 'news flashes' and summaries of the Society's proceedings. The Honorary Secretary, at 4 Sandhurst Road, Sidcup, Kent, will be pleased to send inquirers further information on the Society and its publications.

SCHOLARSHIPS 1958

The Council will consider the following scholarships for award this year:

RESEARCH SCHOLARSHIPS

Ferranti	Value £500 per annum for two years
I.M.E.A.	Value £420 for one year; may be extended
Oliver Lodge	Value £420 for one year; may be extended
Swan Memorial	Value £120* for one year
C. P. Sparks Fund	Maximum grant £100

GRADUATE SCHOLARSHIPS (*for full-time post-graduate study*)

Duddell	Value £400 for one year
Silvanus Thompson	Value £400 for one year

STUDENT SCHOLARSHIPS

Duddell	Value £200 per annum for three years
Silvanus Thompson	Value £200 per annum for three years
Sir Arthur Fleming	Value £120 per annum for four years
Paul	Value £75* per annum for four years
Salomons	Value £60 for one year
David Hughes	Value £60 for one year
Sir Charles A. Parsons	Value £60 per annum for three years
Thorrowgood	Value £25 for one year

The Student Scholarships are awarded to candidates wishing to study at undergraduate level at a university or a technical college and may also be awarded to candidates pursuing an industry-based sandwich course in electrical engineering.

The closing date for the receipt of applications is the 1st May 1958 for Student Scholarships, and the 2nd June 1958 for Graduate and Research Scholarships. Full particulars of the conditions of award attached to each scholarship, and nomination forms, may be obtained on application to the Secretary, The Institution of Electrical Engineers, Savoy Place, London, W.C.2.

* Value may be increased for a candidate of outstanding merit.

SATELLITES (*continued from page 83*)

were now at a time of maximum sunspot activity, which, moreover, was one of unprecedented intensity. He stressed the need for knowing the orbit accurately if best use was to be made of satellite transmitters for ionospheric research. The only people who could do this were the optical astronomers, whose instruments were not handicapped by errors due to refraction through the ionosphere. Their main difficulty was knowing where to look, and Dr. Smith-Rose urged closer co-operation between radio and optical astronomers.

Before closing the meeting, the Chairman read a letter from the Academy of Science of the U.S.S.R. which expressed their regrets at not being able to send representatives, but extended their best wishes for a successful meeting.

The vote of thanks to the contributors showed clearly that the meeting had indeed been a very successful and interesting one.

B. G. P.

ANNUAL DINNER

The number of applications from members wishing to attend the Annual Dinner has greatly exceeded the accommodation available, and a waiting list for returned tickets was opened on the 8th January.

Members who have already received tickets, and subsequently find they are unable to attend are asked to return them without delay, so that their places can be allocated to members on the waiting list.

In accordance with the Council's decision, when the majority of the tickets had been issued, the remainder were issued to members only.

AERIAL NAVIGATION AND AIR TRAFFIC CONTROL

A MEETING IN BERLIN: MAY 1958

The Ausschuss Für Funkortung, whose headquarters are at Düsseldorf, is holding its Annual Meeting in Berlin from the 19th to 24th May 1958, at which Aerial Navigation and Air Traffic Control will be under discussion. The programme is not yet fixed, but it will be divided into nine parts on a basis of subject, ranging from practical experience in aircraft to new scientific developments which might eventually be employed to improve aerial navigation and control. The meeting is open without charge to anyone interested, but the organizers would like to know, as soon as possible, the names of intending participants. Inquiries should be addressed to Ausschuss für Funkortung, Düsseldorf, Am Wehrhahn 94, Germany.

NUCLEAR ENGINEERING

A COURSE IN BASIC PRINCIPLES AT LIVERPOOL UNIVERSITY

The Department of Extra-Mural Studies of the University of Liverpool is arranging a short residential course on the 'Basic Principles of Nuclear Engineering' from Sunday 13th to Saturday, 19th April 1958. This introductory course is intended primarily for qualified engineers and others wishing to learn something of the problems of large-scale nuclear power programmes. It will include a review of the most relevant parts of nuclear physics. The lecturers are Professor H. W. B. Skinner, Professor J. M. Cassels, Dr. L. L. Green and Dr. F. D. S. Butement. Most of those taking the course will be accommodated at Derby Hall, but local students can be accepted on a non-residential basis. Further particulars and an enrolment form may be obtained from the Director of Extra-Mural Studies, 9 Abercromby Square, Liverpool, 7.

OVERSEA ATTENDANCE REGISTER

During the period 17th December 1957 to 15th January 1958 the following members called at the Institution building and signed the Attendance Register of Oversea Members:

ADDISON, J. D. (Kuwait, Arabia)
BEATTIE, J. (Rangoon, Burma)
BOLUS, C. A. (Kuala Lumpur)
BUCKINGHAM, S. D. (Brunei Town, Brunei)
JAMIESON, J. A. A. (Niagara Falls, Canada)
KASARGOOD, S. V. (Bombay)
McDONALD, J. R. (Kingston, Jamaica)
PETTIFOR, P. H. (Johannesburg)
THRUPP, W. F. (Melbourne)
VENKATESWARAN, S. (Palghat, India)

LONDON REPORT

ORDINARY MEETING

Maturity takes Time

Owing, no doubt, to the December fog, the attendance at Dr. J. V. Dunworth's lecture on advanced reactors on the 5th December 1957 was a modest one for a lecture on such a fashionable subject.

Any lack of numbers in the lecture theatre at Savoy Place was amply compensated by the fact that the Irish Branch were listening in Dublin to a direct transmission of the lecture. Mr. L. Collins, the Chairman of the Irish Branch, who proposed the vote of thanks, recorded excellent reception and welcomed the lecture as representing, in some measure, a restoration of freedom of discussion of matters which have for so long been shrouded with a cloak of secrecy.

Since the occasion was the delivery of a lecture, there was no general discussion, but the majority of members present would no doubt have endorsed Mr. Collins's view that Dr. Dunworth had struck a happy balance in presenting a lecture on a comparatively new and complex subject to persons not versed in it.

Perhaps the most significant part of the lecture was the emphasis laid by Dr. Dunworth on the evolutionary aspect of reactor technology. He pointed out that the time which will have been taken from the start of preliminary work on the Calder Hall type of reactor to the commissioning of the first commercial station will be fifteen years. However, the United Kingdom, in 1946, started its work on atomic energy with nothing more than green fields and grey matter, and the time-scale might be compressed for subsequent developments; but even so the immense amount of scientific and engineering effort necessary to carry a new reactor type to the point of commercial application will mean that very few of the many possible types will achieve commercial status. R. H. B.

DISCUSSION MEETING

The Measurement of the Dynamic Characteristics of Electrical Machines

On the 19th November 1957 the Measurement and Control and the Utilization Sections jointly discussed methods of measurement applicable to machines under conditions of change. Controversy ensued immediately. The subject had been announced as *The Measurement of the Dynamic Characteristics of Electrical Machines*, and several contributors expressed the view that this ought to have been *Measurement of Transients*. In any case the topic proved so large that even three opening speakers, Messrs. J. M. Layton, V. N. Manohar and R. A. Stevens, and the many contributors to the lively discussion that followed, could deal with only a few of the many problems of interest.

Mr. Layton and Mr. Stevens dealt mainly with d.c. machines such as rotary amplifiers and especially with the measurement of their frequency response, while Mr. Manohar referred mainly to alternators, describing a torque-meter for recording transient torques and showing a short cinema film in which the movements of the end windings of an alternator stator, resulting from short-circuits, were made visible in slow motion.

The disconcerting fact was soon established by the first speakers, supported by much evidence from others, that even the simplest d.c. machine, not to mention the more elaborate multi-stage machines, behaves in practice in a very different manner from that indicated by the simple differential equations of the textbooks. What is alarming is the extent of these discrepancies. Mention was made of machines in which apparent time-constants could differ from those of the simplest theoretical model by factors of as much as ten. Many contributing causes to such anomalies were pointed out. There is the important and complex effect of the circulating current in the commutating coils and through the brushes under conditions of change, affected by the variable resistance of the brush contact. There are iron losses and hysteresis, and very significant effects from the mutual interference of fluxes in quadrature in saturated iron. Mr. Stevens cited experiments on a Magnavolt amplifier that showed lack of consistency between the responses to a step input and the response to sinusoidal inputs. In the discussion many contributors, including Mr. B. Adkins, Mr. J. W. Parry, Mr. K. F. Raby and Dr. D. G. O. Morris, made useful suggestions regarding the possible explanation of these anomalies and their implication in measurement procedure. The general impression from this part of the discussion was that a real need exists for a more comprehensive experimental and theoretical study of transients in d.c. machines.

Mr. Manohar, in introducing the problems of transient measurement on a.c. machines, referred to the measurement of shaft torque by strain gauges, using a transistor amplifier built into the shaft to minimize slip-ring errors. He also referred to the use of model machines (the so-called *micro-machines*) and the observation of transient forces on windings. The discussion showed that much remained to be done to develop means for obtaining the complete set of measurements necessary to elucidate the behaviour of alternators under transient conditions. Dr. W. G. Thompson in particular referred to the importance of accurate load-angle measurement and the possibility of measuring acceleration by accelerometers based on piezo-electric effects.

The discussion was lively and useful, and it may be hoped that it will stimulate further efforts in this field. A. T.

DISTRICT MEETINGS AT OXFORD

Modern Railway Electrification

The second District Meeting of the session was held at the Oxford office of the Southern Electricity Board in November 1957: Mr. H. H. C. Barton gave a lecture on *Railway Electrification at the Standard Frequency*. This was largely based on a joint paper by Mr. Barton and Mr. E. L. E. Wheatcroft, which was read before The Institution in February 1956. Mr. Barton made a very thorough and comprehensive survey of the general principles of railway electrification, in which he made skilful use of photographs taken in many parts of the world. The relative merits of d.c. and a.c.

electrification at high and medium voltage were clearly defined. Other issues arising directly from electrification were treated, and in particular the important problem of interference with communication circuits was stressed.

The discussion covered, amongst other topics, the pros and cons of regenerative braking and the problems of track adhesion.

Mr. D. Westwood was in the chair, and the vote of thanks was proposed by Mr. J. C. Napier, who complimented Mr. Barton on the fascinating way in which he had covered a complicated subject. D. W.

Modern Aircraft Control

There were fifty-seven members and visitors at the January District Meeting at Oxford to hear a paper by Mr. A. E. Jaquemet and Mr. D. B. Clemow on *The Ground and Air Control of International Civil Airlines*. The lecture traced the development of aircraft communication from 1911 to the present day and clearly showed how new techniques were being developed to keep clear the highways of the air. First and foremost were safety considerations, and Mr. Jaquemet illustrated these by a description of the air channels into London Airport, explaining how the navigational aids ensured the safe, orderly and expeditious movement of aircraft to and from Heathrow.

After a break for refreshments there was a full hour's discussion embracing such topics as the merits of inertial and electronic systems for position finding and the inherent difficulties of language in ground control approach, particularly in countries behind the Iron Curtain.

In proposing a vote of thanks, which was carried with enthusiasm, Mr. D. Westwood congratulated the authors on their neat method of presenting information about maximum usable frequencies. He felt this was a distinct improvement over the conventional charts. W. H. L.

MEASUREMENT AND CONTROL SECTION RADIO AND TELECOMMUNICATION SECTION

Cascading Dekatrons!

This expression might be very aptly used to express wonder and delight at the spectacle of decades of small cold-cathode counting tubes which looked rather like miniature catherine wheels and which, in the course of a demonstration, behaved themselves admirably. The demonstration followed the reading of a paper entitled *Dekatrons and Electro-Mechanical Registers operated by Transistors* by G. B. B. Chaplin and R. Williamson on the 3rd December 1957. This was just the first of a series of four papers presented and discussed at a well-attended combined meeting of the Measurement and Control and the Radio and Telecommunication Sections, under the chairmanship of Mr. H. S. Petch. The four papers are reviewed on pp. 86–90.

Dr. Chaplin explained that the secret of the good behaviour of Dekatrons is to drive them properly, and, of course, what better way than by transistors? Although in the subsequent discussion Mr. L. C. Burnett considered the necessity of specifying waveforms for Dekatrons as something of a 'Harwell fairy tale', Dr. Chaplin maintained that the excellent characteristics of the present scaler were the direct outcome of this policy. Both Mr. F. Holmes and Dr. J. E. Flood fished for information about applications of this Dekatron counter scaler. Could it be applied to parallel printing techniques, logical circuits, etc.? And anyhow, what did it cost? Dr. Chaplin, however, did not rise to this bait, since such mundane things as applications and costs had never been considered. Apparently the development had all been done in the cause of pure science.

Mr. G. M. Ettinger then read his paper entitled *Some Aspects of Half-Wave Magnetic Amplifiers*, but it was a pity that this followed the usual pattern we have come to associate with papers on this subject, namely masses of curves and data, which produce a general feeling that one cannot see the wood for the trees. Mr. Ettinger would have been better advised to stick to the salient features, taking greater pains to explain clearly just what the problem was and how far his analysis had helped in its solution, without being so anxious to give us the whole works. Details of the analysis could safely be left to those sufficiently interested to study at their leisure. Magnetic amplifiers are such useful devices that they deserve a better fate than has so far been accorded them. In the discussion, Dr. E. H. Frost-Smith—one of the *cognoscenti*—challenged one or two points, which Mr. Ettinger afterwards neatly contrived to side-step, but it is questionable if anyone else present really appreciated the subtlety of the argument.

Dr. Chaplin, having by now got his second wind, then discoursed on the evening's *pièces de résistance*, which were the following two papers both written in conjunction with Mr. A. R. Owens: *Some Transistor Input Stages for High-Gain D.C. Amplifiers*, and *A Transistor High-Gain Chopper-Type D.C. Amplifier*.

A preview of this work was given at a discussion meeting on the 26th March 1957, and, in the present papers, the i's have been dotted and the t's crossed. In their formal presentation the papers certainly appear to be very useful and instructive. Having, in the first paper, generally surveyed all possible ways of using germanium transistors in d.c. amplifying circuits, the authors concentrate, in the latter paper, on what they regard as the most promising method—one well enough known and tried with mechanical choppers, but all the more attractive when these can be eliminated in favour of transistors. Briefly, an amplifier has been produced having a current drift of only 4×10^{-9} amp, and a voltage drift of less than 100μV in the range 20–50° C. If one takes pains to control the temperature, the drift can be reduced to about 3×10^{-10} amp. A limitation is that the bandwidth is restricted from direct current to about 25 c/s.

The discussion of these papers, which was long and hearty, was opened by Mr. I. Wilson, who tendered some good advice on the application of the amplifier to analogue computing. Mr. F. Oakes related his experiences about matching transistors in directly coupled amplifiers, although he still agreed that the chopper type was superior. Mr. J. S. Walker reminded us again that there is nothing new under the sun. The human eye, when gazing upon a scene which is not fluctuating in pattern or intensity, executes very small movements which effectively chop the signals. Mr. D. C. Pressey was curious to know how linear the amplifier was. Mr. P. J. Price had some advice to offer about ways of increasing the bandwidth of 25 c/s and asked about possible methods of obtaining a good phase margin. Dr. C. J. Candy also offered some comments on this question, and suggested means of reducing noise.

Mr. Owens, in replying to the discussion, was very frank about the difficulties and limitations associated with the use of germanium transistors. He did not think that the grow

silicon transistor would be very successful as a chopper, mainly because of the relatively high series resistance, although alloy-junction types appear to be promising. Some speakers had referred to questions of phase, but in the rather unsophisticated atmosphere of Harwell they do not measure phase! But at least the amplifier was linear.

A very successful and convincing demonstration was given, the output from a model of the chopper-type amplifier operating a large servo-controlled pointer. When Dr. Chaplin put his finger on a thermocouple connected to the input, large deflections were obtained, but for long periods in the absence of stimulation the pointer was as 'constant as the northern star, of whose true-fix'd and resting quality there is no fellow in the firmament'.

A vote of thanks to the authors, proposed by the Chairman, was carried with acclamation. J. K. W.

SUPPLY SECTION
SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE

French and British Power-Station Practice

'Give it an understanding, but no tongue.' So might Hamlet's soliloquy on his father's ghost have applied to Monsieur J. Pimpaneau's lecture to the joint meeting of the Supply Section and the British Section of the Société des Ingénieurs Civils de France at The Institution on the 18th December.

The subject was *The Planning and Construction of Large Modern Thermal Generating Stations*. An abstract in English had been issued beforehand, and the lecture was confined to the showing of lantern slides illustrating the principal characteristics of the Électricité de France system and giving views of French power stations. Unfortunately, owing to ambassadorial demands, M. Pimpaneau's interpreter could not be present, but Mr. G. Froud stepped into the breach and assisted with a running commentary improvised at short notice.

Perhaps the main impression from the discussion was the general similarity in France and Britain of the problems arising and the solutions adopted. There was, however, some noteworthy dissimilarity. Mr. F. H. S. Brown wistfully pointed to the deep flowing rivers alongside most of the French stations seen in the slides. If Britain were equally endowed with copious inland water, a vociferous section of the British Press and public would have less opportunity of castigating these hyperbolic adornments of the countryside known as cooling towers. In this connection, Mr. Brown referred to the C.E.A. experiment in 'dry' cooling towers, which, though larger than the present type, require much smaller supplies of water and hence give more freedom in selecting inland sites. He compared the French policy of standardizing on 115 MW sets with the C.E.A. plans for large sets comprising 120, 200 and 275 MW units and one unit of 550 MW. In British eyes there was a danger in too much standardization in the present tempo of development, particularly in view of the possible effects of nuclear generation on the design of generating units and the increasing need for two-shift working on all but a few base-load plants.

M. Pimpaneau's claim that the operating staff of a modern station is 0·4 man per megawatt—about one-tenth the figure for older stations—was taken up by most of the speakers in the discussion. Mr. D. B. Irving, who spoke with ease and charm in French, wanted to know how this low figure was achieved. He also enquired how nuclear developments would affect the future planning of Électricité de France.

This latter point was taken further by the next speaker, Mr. F. J. Hutchinson, who stressed the complementary nature of pumped-storage schemes to base-load nuclear generation. He advocated aerial survey and photography as a convenient means of obtaining site plans for preliminary layout purpose, when physical access is denied by the owners. Amongst other points he referred to the fire risks associated with central control rooms, and the disposal of fly ash, and defended the efficiency of cooling towers—when the wind is in the right quarter.

Mr. W. J. Price, in a breezy speech appreciated by an audience more often subjected to the somewhat arid logic of technicalities, stressed the differences between French and British conditions. He maintained that the striving for higher temperatures and pressures should not be allowed to obscure the need to devote attention to the 'wet back end' of the turbine, which generates a quarter of the total power. He drew an analogy between the wastage of natural gas in Persia and the wastage of 30 million tons of coal a year in Britain through the rejection of low-temperature heat from the cooling-water system into the sea, and asked whether 'instead of having beautiful lawns, which are very fine and aesthetic, we could not have an acre of glass greenhouses for every 20 MW and use the heat for them. We might be doing something not for the next decade but for the year 2000.' During his advocacy of mechanical-draught cooling towers, Mr. Price amused his audience with a lament over an ideal power-station site that was used for a slaughter-house.

On a more restrained note, Mr. A. W. Pedder argued that the formulae quoted by M. Pimpaneau relating to the economic development of a station must be used with discriminating judgment; they became interesting only when applied to a specific instance, and Mr. Pedder said he would like to know what figures M. Pimpaneau would substitute in the equation in the example of the 250 MW turbines which had been ordered.

The last speaker, Mr. R. F. Alexander, emphasized that the large water demand of nuclear generating stations inflated the cost of civil engineering works. He urged the greater use of pre-stressed concrete and lighter construction for station buildings. Returning to the question of operating staff, he claimed a figure of only 0·2 man per megawatt for a new station in North America.

M. Pimpaneau replied briefly to the discussion, and, though obviously handicapped by the language difficulty, adhered to his views about operation staff, the use of formulae for future planning and the theoretical efficiency of cooling-tower stations.

Winding up the discussion, Mr. B. A. E. Hiley, President of the British Section of the Société des Ingénieurs Civils de France, added a few points from his own long experience of station construction with special reference to ash disposal and the protection of fish. He concluded by proposing a vote of thanks to M. Pimpaneau, delivered courageously in French.

The meeting provided an excellent forum for the discussion of trends and problems ranging widely over the field of electricity generation. Though only moderately attended (probably owing to the close approach of Christmas) the meeting achieved more than average success and elegance partly by the broad interest of the subject and partly by the presence of distinguished visitors from both sides of the Channel. D. P. S.

NEWS *from the Centres*

NORTH MIDLAND CENTRE

Annual Dinner

The North Midland Centre held their Annual Dinner on the 15th November at the Queen's Hotel, Leeds, presided over by Mr. A. J. Coveney. It was a very successful evening attended by 250 members and visitors. The toast of The Institution of Electrical Engineers and the North Midland Centre was proposed by Engineer Rear-Admiral Sir Sydney Frew, who referred to the benefits conferred on mankind by the triumvirate of the senior engineering institutions. He said that the problems of industry were getting very wide, and that the skill of the electrical engineer was of particular value in communication systems with ships and aircraft. He paid tribute to Sir Ambrose Fleming and his work, and stressed the value of education. Our President, Mr. T. E. Goldup, spoke of the task of kindling the fire of enthusiasm in the young so that in due course they would be ready to take our place in industry and in the ranks of The Institution. He also called for generous support for the Benevolent Fund. The toast of the guests was proposed by Mr. A. J. Coveney, who mentioned the custom of the Centre to arrange for an eminent member of the Church to be invited to join us. The Rev. Professor J. K. S. Reid responded, and in a very witty speech illustrated that scientific knowledge alone was not sufficient, and that the genuine and ultimate good of mankind could be achieved only by the marriage of technology with the humanistic studies and the arts. After the meal there was time for members to circulate and meet old friends and thus round off a very pleasant evening.

Utilization Group

At the Utilization Group meeting on the 19th November, with seventy members and guests present, the Chairman, Mr. J. L. Browell, welcomed Miss Miriam V. Griffith, who read a paper on *Some Aspects of Heat Pump Operation in Great Britain with particular reference to the Shinfield Installation*. This proved to be an interesting description of an experimental installation and pointed to a possible expanding future for this type of scheme. After a rewarding discussion, the Chairman proposed a vote of thanks, congratulating Miss Griffith for her clear and concise presentation, and the able way in which she dealt with points raised in the discussion.

Transistors and Radio

The third ordinary meeting held on the 3rd December 1957 was attended by eighty-two members, under the chairmanship of Mr. A. J. Coveney. A lecture was given by A. J. Briggs and E. Wolfendale on *The use of Transistors in Radio and Television*. The lecture dealt mainly with the application of transistors to portable and car radio receivers and included some very interesting exhibits. A film and slides were also shown dealing with the fundamental design of transistor circuits and illustrating the evaluation of an equivalent circuit. A vote of thanks was proposed by Mr. Coveney, who referred to the lecture as a happy blend of theoretical and commercial aspects, and said how interesting and fascinating it was to listen to authorities dealing so capably with their own particular subject.

By courtesy of the 'Yorkshire Evening Post'

A cheerful group at the North Midland Centre Annual Dinner

L. to r.: Mr. W. K. Brasher, Engineer Rear-Admiral Sir Sydney Frew, Mr. T. E. Goldup, Councillor Bertrand Mather, The Rev. Professor J. K. S. Reid and Mr. A. J. Coveney.

District Meeting at Hull

The second District Meeting of the session at Hull, on the 5th December, was the second joint meeting with the North Midland Graduate and Student Section. The chair was taken by Mr. W. S. Milner, convener of the Hull District Meetings. This was the fourth occasion on which Mr. R. S. Wignall has given his paper on *Project Considerations for Diesel-Electric Traction*, which was well illustrated with lantern slides and by examples of projects for railway schemes in all parts of the world. The author very clearly showed that much detail work is required in preparing a project of this type, involving in many cases a most comprehensive study of the route of the railway under consideration. Schemes involving standardized types of locomotive are not generally applicable owing to marked variations between railways in different countries such as different loading gauges or operative altitude, which affects both the engine and the cooling devices of the locomotive. Following the presentation of the paper, a discussion was opened by Mr. R. M. Dymond, who was joined by five other speakers, and after Mr. Wignall's replies to the diverse questions put forward, a vote of thanks was proposed by Mr. H. Myers, Chairman of the Graduate and Student Section. This was carried in the usual manner. Twenty-three members and visitors attended.

Social Students

The Graduate and Student Section held their Annual Joint Dance with The Institutions of Civil and of Mechanical Engineers on the 6th December in the Leeds University staff refectory. The function was well supported and was enlivened by an entertainment provided by an excellent troupe from the Yorkshire Electricity Board headquarters at Scarcroft. It was generally voted a most successful evening.

Transistors and Mhos

The fourth ordinary meeting was held on the 7th January 1958, with Mr. A. J. Coveney in the chair. Ninety-five members attended to hear two papers by Colin Adamson and L. M. Wedepohl dealing with *Power System Protection, with particular reference to the Application of Junction Transistors to Distance Relays*, and *A Dual-Comparator Mho-Type Distance Relay utilizing Transistors*. Although the papers are

ow in their second year it was obvious from the attendance nd the discussion that interest has not diminished. A vote of hanks was proposed by the Chairman, who pointed out how ifficult it is to present highly technical papers in a clear, oncise and interesting fashion. He congratulated the authors n having achieved this and also complimented them on the y in which the extensive discussion had been dealt with. ince further research on the subject was proceeding, the hairman hoped that we would in due course see the authors gain with results of their further work. W. J. W.

SOUTHAMPTON: SOUTHERN CENTRE

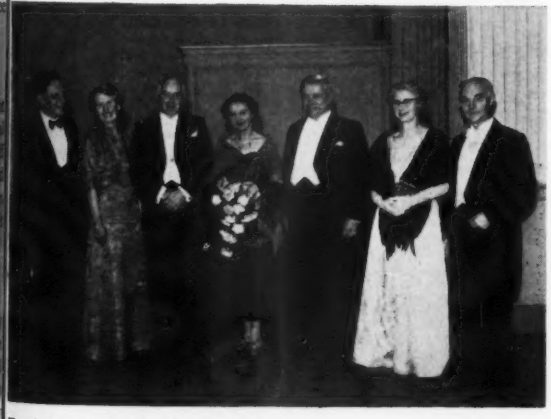
Mr. G. S. C. Lucas, one of the Vice-Presidents of The Institution, was welcomed to the Southern Centre Annual Dinner and Dance at the Polygon Hotel, Southampton, on the 12th December, by the Chairman, Dr. L. G. A. Sims, and by a record attendance of Southern Centre members and guests.

Mr. Lucas responded to the toast of The Institution, and referred to a growing need for collaboration between university colleges, technical colleges and industry, which the Council considers important. The Vice-President also referred to the increasing importance of the Southern Centre, which had developed from the Hampshire Sub-Centre and which now had a membership of 1 833. He forecast that professional electrical engineers would play a more decisive role in the life of our country. Members of our profession had achieved a great deal over the past few decades and were well established in industry and in the universities. The great works of electrical engineers in the past would certainly be surpassed in the future.

Among the guests were Dr. T. E. Allibone and Mrs. Allibone; Mr. W. Chamberlain and Mr. I. Wilson (Chairman and Secretary of the Southern Association of The Institution of Civil Engineers) and Mrs. Chamberlain; and Mr. D. L. Brown and Mr. E. Blorr (Chairman and Secretary of the Southern Branch of The Institution of Mechanical Engineers).

The toast of The Institution was proposed by Professor W. I. Lucas, Deputy Vice-Chancellor of Southampton University, who praised the achievements of electrical engineers. E. A. L.

By courtesy of the 'Southern Daily Echo'



Festivity at the Southern Centre

L. to r.: Professor and Mrs. W. I. Lucas, Dr. L. G. A. Sims, Mrs. and Mr. G. S. C. Lucas, and Mrs. and Dr. T. E. Allibone.

NEWS *from Abroad*

QUEENSLAND OVERSEA COMMITTEE

A Visitor from Sweden

During a visit to Australia, Mr. P. Skokby, Manager of the Lightning Arrester and Capacitor Department, A.S.E.A., Sweden, addressed a meeting organized by the Queensland Oversea Committee and held at the University of Queensland on the 15th October 1957. The lecture was in two parts: (i) *The Reduction in Insulation Levels for Extra-High-Tension Lines as the Result of Improvement in Lightning Arrester Characteristics*, and (ii) *Series Capacitors in their Application for Improvement in the Performance of Transmission Lines.*

Mr. Skokby began by outlining the fundamental characteristics of the valve-type lightning arrester, grouping them under characteristics relating to the protecting efficiency of an arrester and characteristics relating to the strength of the arrester.

The discharge voltage of a lightning arrester should be as low as possible; 2·6 and 2·8 times the voltage rating at 5 and 10 kA respectively are now quoted. Until recently, discharge voltage was the prime consideration in protecting efficiency, but recently some attention has been given to the sparkover voltage. A minimum 50 c/s sparkover voltage has always been guaranteed to avoid unnecessary operation on switching surges which are not dangerous to plant insulation. However, the sparkover voltage at 50 c/s should not be too high because this would unduly increase the front of wave sparkover voltage. A factor of two is reasonable and a tolerance of $\pm 10\%$ appropriate. If the gap-breakdown voltage is set too high, the arresters may never function. Higher values of the sparkover voltage are sometimes specified, but it is doubtful whether such a policy is correct. Recent investigations in the United States have shown that the strength of transformers against switching surges is some 15–20% below the basic insulation level on impulse.

Naturally, if the arresters function on switching surges, the duty on them will increase greatly with the voltage and line length, since they have to take care of the stored energy of the line and any capacitance installed on it.

In commenting on the strength of the arrester itself, Mr. Skokby pointed out that the 100 kA surge strength was a valuable test of the mechanical strength. It is advisable to have a good margin of voltage rating (i.e. reseal voltage) between the supply voltage across the arrester and the cut-off voltage, so that under the most adverse conditions the arrester can still reseal. Of course, this margin must not be too great since higher voltage rating means higher protecting level.

The discharge voltage of the heavy-duty high-voltage arresters is so low that the 50 c/s sparkover voltage determines the protective level. Mr. Skokby believed therefore that it was of little avail trying to reduce discharge voltage further, and greater attention must instead be paid to the 50 c/s sparkover voltage. The maximum figure of 2·2 times the cut-off voltage should never be exceeded for a good arrester, and, since such an arrester should have to take occasional switching surges, it is important that the blocks should have sufficient long-wave strength. For medium-duty and line-type arresters, where the discharge voltage is relatively much higher, especially at the lower distribution voltages, the discharge

voltage may still determine the protective level, and here any reduction in discharge voltage is welcome.

With regard to the heavy-current long waves which are produced on high-voltage long lines owing to the restriking of the circuit-breaker, the modern tendency is now to have breakers which do not restrike repeatedly, so as to build up the voltage to such high values that the arresters spark over. This, at least, is European practice, and, although Americans recognize it, they state that such breakers would be too expensive. Agreement has not yet been reached on this point. Repeated restrikes at high voltages cause considerable stress on the transformer windings, and the restrikes should therefore be avoided even if arresters are not endangered.

Mr. Skokby illustrated special applications such as generator protection and in conclusion he outlined recent developments in the application of series capacitors, mainly as applied to voltage improvement on distribution lines.

Christmas Luncheon

The Institution Christmas Luncheon in Queensland took place last year on the 5th December at Manhattan Hotel in South Brisbane. Thirty-five members accepted the invitation to attend and took the opportunity of exchanging greetings and renewing associations before sitting down at the luncheon table.

On this occasion the guest speaker was Professor H. C. Webster, Professor of Physics at the University of Queensland. Professor Webster is the Australian Convenor of the International Geophysical Year, and it was therefore most appropriate that he took the I.G.Y. for his subject.

He related the sequence of events leading to the establishment of the I.G.Y. and then described the scope of investigation which ranges through a study of the earth's interior, oceanography, glaciology, meteorology and an investigation of the ionosphere.

The need for continuous observations of such matters as temperature, pressure and cosmic radiation in the upper atmosphere led to the idea of launching an earth satellite, which, by orbiting the earth and transmitting signals, could relay much valuable information on the condition of the upper atmosphere.

In this regard the Russians have already achieved some measure of success, the main disadvantage being that the period of signalling is limited to the life of the battery installed in the satellite. Once the American satellite is launched it will have the advantage of being equipped with a solar battery, which, it is anticipated, will be able to transmit signals so long as the satellite is orbiting.

Mr. McCulloch proposed a vote of thanks to the speaker. He stated that engineers recognize the importance of physics in their basic training and expressed appreciation of Professor Webster's top-ranking ability in the field of ionospheric research.

W. I. G.

SOUTH AUSTRALIA OVERSEA COMMITTEE

Clipped Accents

At the final technical meeting of 1957, held on the 4th October, Mr. A. J. H. Oxford, Chairman of the Oversea Committee for South Australia, gave a talk on *The Transmission of Speech in Restricted Bandwidth.*

Mr. Oxford introduced the subject by describing how speech sounds are produced. With the aid of diagrams he showed that the vocal mechanism of a human being was a relatively simple modulated-carrier transmitter, the carrier taking the form of a hiss or a buzz modulated by vocal cavity resonances. An electronic simulation of the process can be controlled by a few slowly varying signals, each requiring a bandwidth of less than 20 c/s. The speaker demonstrated a resonance vowel synthesizer, in which the hiss and buzz waveforms are generated electrically and the *formant* or modulating resonances are electrical filters.

Mr. Oxford went on to describe the first complete analysis-synthesis system for transmitting speech over a channel of restricted bandwidth—the Vocoder. This makes use of the slowly varying nature of the speech spectrum to achieve a bandwidth reduction of approximately 10 : 1. Some work based on the Vocoder principle is being carried out at the Weapons Research Establishment at Salisbury (South Australia), and Mr. Oxford played a tape recording of speech processed by a machine similar to the Vocoder, capable of 3 : 1 bandwidth reduction. In this equipment, speech frequencies in the range 300–1 000 c/s are transmitted direct, and the Vocoder technique is used to transmit the upper range 1 000–3 600 c/s, using a noise waveform (or hiss) in place of the upper harmonics of the larynx waveform.

Since the speech carrier is modulated slowly, its waveform is repetitive over several cycles of the larynx fundamental frequency. This fact led Dr. D. Gabor to propose a system of bandwidth compression which samples and transmits only every *n*th larynx cycle and replays each of these $(n - 1)$ times. The time of n cycles is thus available to transmit only one cycle, and a bandwidth reduction of $n : 1$ may be achieved. This system suffers from the difficulty that, unless the sampling is synchronized with the larynx frequency, transients are introduced which result in a distorted output.

Formant coding (or the Resonance Vocoder) has received considerable attention in recent years. Mr. Oxford described a system developed by the Signals Research and Development Establishment, pointing out that the vowel synthesizer demonstrated at the beginning of the lecture belonged to the same class. A tape of the output of the S.R.D.E. equipment, made in October 1956, was played, and it strikingly demonstrated the possibilities of readable transmission with the remarkable bandwidth reduction of 25 : 1.

Mr. Oxford concluded by briefly describing, and playing tapes of, the Vobanc and Phoneme Recognition systems developed in America.

Opening the discussion, Professor Willoughby mentioned some work being carried out at the University of Adelaide based on the Vobanc principle. The equipment was described by Messrs. Bogner and Smith, who played tapes of the results achieved.

Elections and Resignations

At a meeting of the Oversea Committee for South Australia held on the 30th October, Mr. Oxford was re-elected Chairman for 1958. Mr. J. W. Harrod was elected to the office of Vice-Chairman, succeeding Mr. M. E. Richards, who retired after serving in that capacity for four years. The Committee wished to place on record their warm appreciation of Mr. Richards' enthusiastic services. Mr. G. Ellesworth and Mr. S. G. Ross were elected to fill vacancies on the Committee caused by Mr. Harrod's election and the resignation of Mr. Newstead who has recently been appointed to the Chair of Electrical Engineering in the University of Tasmania.

J. W.